From: Natalie Risner
To: Comments@DOC
Subject: Aquifer Exemption comments
Date: Wednesday, December 16, 2015 6:47:55 PM
Attachments: NEWFInalforaquiferexemption.pdf
wellcasingfaliure.pdf
Importance: High

Hello I already sent this letter in at 3:30 today but realized forgot my attachment mentioned in the letter to I am resubmitting. Thank you so much

Natalie Risner

NATALIE SMITH-RISNER

Ex. 6 - Personal Privacy

December 16, 2015

Tim Shular
Department of Conservation
801 K Street, MS 24- -0202
Sacramento, CA 9581 4

Proposed Aquifer Exemption

To DOGGR:

This letter is in response to the 15-Day Supplemen tal Public Comment period for the request by FREEPORT-MCMORAN OIL & GAS for an Aquifer Exemption Expanded Boundary at the Arroyo Grande Oil Field. The project is located at 1821 Price Can yon Road (San Luis Obispo) on the east and west sid es of Price Canyon Road, approximately 2.7 miles north of the City of Pismo Beach, in the South County planning area (San Luis Bay Inland sub area South).

My name is Natalie Smith-Risner and my family owns property at **Ex. 6 - Personal Privacy** **Ex. 6 - Personal Privacy**. Our property is located approximately 6,300 feet to the northeast of Ormond Road and Price Canyon Road intersection. Our parcel is located adjacent to the Arroyo Grande Oil field (AGOF) boundary. Our USDW is located approximately 1/10 of a mile from the proposed aquifer exemption boundary. My family has owned this ranch property since 1979 and we utilize the land for livestock and residential purposes. We currently ha ve water well used for beneficial purposes on our property (e.g. livestock, water supply, drinking wa ter, etc.) and our primary concern is that the prop osed activities will compromise the integrity, quality, and/or quantity of our existing underground source of drinking water (USDW) system. This letter our seco nd letter that we are sending as we have not had previous questions we submitted answered. We have a growing concern as do many of our surrounding neighbors. We also have concerns about air quality and noise pollution that potentially will be affec ted from activities at AGOF.

1 There is a recent study that came out with evidence of earthquakes and faults being reactivated from injection of wastewater from enhanced oil and gas e xploration. There are a number of faults in the ar ea and this could affect our groundwater supply and sa fety above ground. One of the sides of the boundary

PHONE (805) 441-0811
EMAIL natalie811@aol.com
ADDRESS 125 Tolosa Place | San Luis Obispo, CA 93401

line is a fault. I understand this is a good block of underground water flow but do we know this activity so close by will not activate this Echa Fault? There is simply not enough research done on this to be using a fault line as a barrier. Below I have attached some articles and information on this subject:
http://www.usgs.gov/newsroom/article.asp?ID=4144#.ViCNv36rSUl

"Wastewater injection into undisturbed formations is also more likely to induce earthquakes than injection for enhanced oil recovery. The durations and volumes for both kinds of wells are similar. The difference between these wells is that enhanced oil recovery injects large volumes of fluid into depleted reservoirs where oil and gas have already been extracted and recycles produced water such that the pressure within the injection reservoir rarely exceeds the preproduction level. In contrast, wastewater injection is injected into virgin formations and thus raises the pore pressure from their initial levels. Avoiding pore-pressure increases within reservoirs reduces the likelihood of enhanced oil-recovery operations inducing earthquakes." (From USGS see link below).
https://profile.usgs.gov/myscience/upload_folder/ci2015Jun1012005755600Induced_EQs_Review.pdf

1

Some other articles on the subject are as follows:

http://www.npr.org/2015/04/23/401624166/oklahomans-feel-way-more-earthquakes-than-californians-now-they-know-why

http://onlinelibrary.wiley.com/doi/10.1002/2014GL062730/full

http://earthquake.usgs.gov/research/induced/

Our next area of concern is the Well Casing Safety for steam injection wells. The steam injection wells proposed to be installed and currently in use at Arroyo Grande Oil Field represent a great increase in risks my family will have to face. A study completed in 2008 shows the high rate of failure of well casings. I worry that with out-of-date regulations for the oil and gas industry compared with the new techniques for oil extraction which operate beyond the scope of older regulation standards. I am attaching an article from an oil industry's periodical regarding this issue; the proposed techniques for oil development in the Arroyo Grande Oil Field represent safety hazard which are not currently well understood or regulated. Further review of the methods proposed and this analysis of the industrial activities must take into consideration. "Casing failure rate is high in steam injection wells and especially in cyclic steam injection wells." (see attached article "Casing Failure in Cyclic Steam injection wells")

In a letter from the Regional Water Board Dated May 14th 2015 to the applicant Freeport MMR a list of items were given to the applicant that the water board was ordering be added to the application for the aquifer exemption under section 13267. (

http://geotracker.waterboards.ca.gov/regulators/deliverable_documents/9581745982/05-14-2015_Freeport-McMoRan%20Oil%2013267.pdf). In this letter it states a list of wells and location map of all water wells within one mile of all injection wells must be provided. It also states they require information for each identified water supply well, including the well owner name and contact information; type of well (i.e. domestic, irrigation, industrial, etc.); whether any of the water is used for domestic purposes; status (i.e. active, idle, etc.); well construction, including screened interval depths; borehole geophysical logs; and all analytical results for any water sample collected from each water supply well. Notify Central Coast Water Board staff within 24 hours upon determination that any water supply well information cannot be obtained from the California Department of Water Resources because it is confidential.

My family's property is within this 1 mile zone from injection wells. Our well has not been tested and we have not been contacted by the applicant. None of my neighbors have been contacted either so this has not been done. So they have not completed this order from the Water Board. This application is lacking information and needs to be completed. We also request that a numerical groundwater model be completed for the area. We must know where are water is going and coming from to be sure that our USDW's are not at risk.

Another issue I have with this project is with this large increase in the Aquifer Exemption boundary and how this will affect property values and/or even desirability of adjacent properties considering the stigma this exemption will cast on our property given the extension of the aquifer exemption up to our property line. My family should not be affected negatively by my neighbor's industrial activities. Who is responsible for putting these surrounding properties at risk of our neighbor's activities?

My next concern is Oil Extraction Well Abandonment and Long Term Risks. Who is going to safely abandon these wells and clean up and reclaim the land when the oil companies have completed their extractions and have moved on, sold out or declared bankruptcy? If we are left to deal with the consequences the oil well developers didn't anticipate or consider, who will assure that their short term gain will not cause more damage in the long run to the community and the county after the oil well developers are done with sucking everything they can out of our land? Have you considered the exit plan?

http://www.npr.org/2015/10/19/449976530/with-abandoned-gas-wells-states-are-left-with-the-cleanup-bill

Thank you for your time

Natalie Risner and Bailey Smith

IADC/SPE 114231

Casing Failures in Cyclic Steam Injection Wells

Jiang Wu, Martin E. Knauss, and Torsten Kritzler, SPE, Chevron

This paper was prepared for presentation at the IADC/SPE Asia Pacific Drilling Technology Conference and Exhibition held in Jakarta, Indonesia, 25–27 August 2008.

Abstract

Casing failure rate is high in steam injection wells and especially in cyclic steam injection wells. The high casing failure rate in such wells is related to the high casing temperature elevation from steam injection. Casing failures varies from casing ID restriction (including buckling and/or collapse) to casing parted (including leak and/or hole). This paper presents a modeling and analysis on casing temperature elevation, casing thermal stress/strain, and casing failure mechanisms in steam injection wells, with comparing with previous casing failure field-data from a Chevron steam injection project. It shows that high thermal axial compressive stress/strain can cause casing hot-yield and is attributed to casing ID restriction (including buckling and/or collapse), and high thermal axial compressive-tensile stress/strain alternation in cyclic steam injection can cause casing fatigue and is attributed to casing parted (including leak and/or hole).

Casing strain-based design seems needed for steam injection wells to take into consideration of casing hot-yield due to high thermal axial compressive stress/strain and casing thermal axial compressive-tensile stress/strain alternation on cyclic steam injection operation. Casing hot-yield and fatigue analysis approach presented in this paper may be used on casing strain-base design for steam injection wells to reduce casing failures, with selecting proper casing grade and weight to reduce casing hot-yield and casing fatigue.

Introduction

Chevron operates in many heavy-oil fields worldwide, and production casing failure is a concern on steam injection operations in these fields. This paper presents modeling and analysis on casing temperature, thermal stress/strain, and casing failure mechanism in steam injection wells, and compares with previous casing failure data from Chevron's Bakersfield Cymric 1Y steam injection project. Recommendations on casing design in steam injection wells are made, which have been used in Chevron's steam injection projects with good results.

Figure 1 shows the number of cumulative casing failure wells vs. the number of total wells in Cymric 1Y steam injection project from 1992 (the starting of Cymric 1Y project) to 2002, where the casing failure rate was about 19%, with casing failures being occurred in 69 wells out of total 370 wells completed and operated in that period.

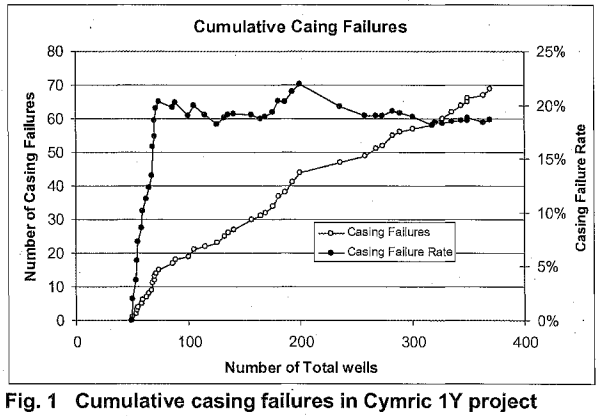


Fig. 1 Cumulative casing failures in Cymric 1Y project (before 2002).

Each of the casing failure occurred after 21 to 108 cycles of steam injections in Cymric 1Y project (Fig. 2).

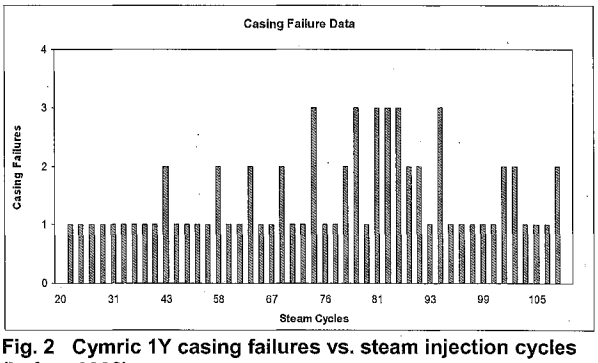


Fig. 2 Cymric 1Y casing failures vs. steam injection cycles (before 2002).

The casing failures can generally be classified as two major types or categories: (1) casing ID restriction, including casing collapse and buckling, and (2) casing parted, including casing hole and leak. The following Table 1 lists the number and percentage of each type of casing failure, from the failed 69 wells out of the total 370 wells.

Table 1. Cymric 1Y Casing Failures (before 2002)

Casing Failure Types	# of Failed Casing	% of Failures
ID restriction, collapse, buckling	29	42.03%
Parted, hole, leak	32	46.38%
Not sure which of above	8	11.59%
Total	69	100.00%

The casing data and cyclic steam injection operation data in Cymric 1Y project are listed as follows. The typical casing schematic and the casing failure locations (around surface casing shoe depth and perforation depth) observed in Cymric 1Y project are illustrated in Fig. 3.

- Surface casing: 10 ¾" casing, 40.5#/ft, K55, BTC @ 380 ft.
- Production casing: 7", 23# or 29#, L80, Hydril 563 @ 1500 ft.
- All cement top to surface. Foam cement used for production casing.
- Tubing: 2 7/8", 6.5#, L80, EUE. Packer or No packer.
- Perforation depth from 1100-1400 ft.
- Steam injection temperature ~550 deg. F, injection pressure ~ 1100 psi.
- 3200 Barrels steam injected over 60 hours.
- Soak time: 2 days
- Production rate 100 BOPD with 65% water cut. (285 BPD gross)
- Flow back pressures start at 700 psi and end around 250 psi.
- Flow back time of 20 days.
- Steam injection and oil production through tubing (puff and huff).

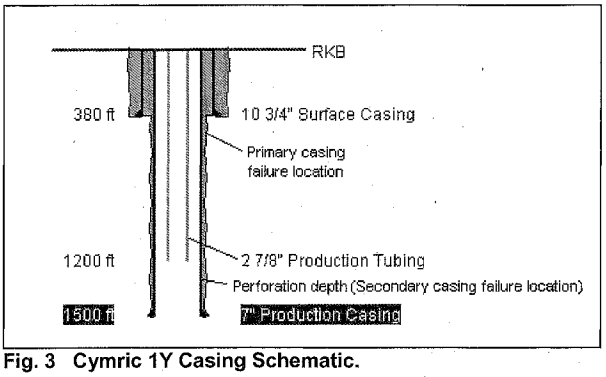


Fig. 3 Cymric 1Y Casing Schematic.

Casing Failure Analysis

1. Casing Hot-Yield

Casing temperature and thermal stress/strain are modeled for the cyclic steam injection operation in Cymric 1Y project to understand the casing failures. Fig. 4 presents the modeled casing temperature profiles for the three periods of cyclic steam injection operation (steam, soak, and production), with comparing with the initial casing temperature (the undisturbed formation temperature).

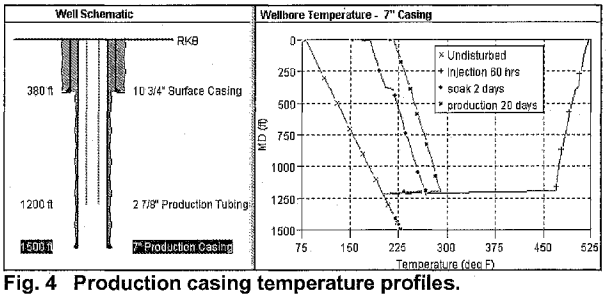


Fig. 4 Production casing temperature profiles.

The production casing temperature is seen to increase up to about 525 deg. F at the top of casing and up to about 475 deg. F at the bottom of casing in the steam injection period. The net casing temperature increase over the initial (undisturbed) temperature is then about 440 deg. F at the top of casing and about 260 deg. F at the bottom of casing. We know that an increase of casing temperature will induce a casing thermal compressive axial stress when the casing is fixed or restricted from thermal expansion in the casing longitudinal direction by cement and wellhead. The higher the casing temperature increases in steam injection period, the larger the induced casing thermal compressive axial stress is generated. Although the highest casing temperature increase is shown at the top of production casing, the casing failures were not observed there, but at around the surface casing shoe depth and perforation depth. The explanations may rely on two reasons: (1) casing thermal compressive axial stress at the top of casing may be less than that predicted by fixed-ends model, as casing may not be completed restricted at the top due to possible up-movement of surface formation from thermal axial expansion, and (2) cement and surface casing may provide a protection to the inside production casing section against formation lateral-movement from thermal radial expansion.

To the middle section of production casing, it can be considered completely restricted from thermal expansion in longitudinal direction, and the casing thermal compressive axial strain ($\Delta\varepsilon$) and stress ($\Delta\sigma$) due to the increase of casing temperature can be directly calculated by using casing thermal expansion coefficient (α), casing temperature increase (ΔT), and casing material Yong's modulus (E):[1]

$$\Delta\varepsilon = \alpha\Delta T \qquad (1)$$

$$\Delta\sigma = -\alpha E \Delta T \qquad (2)$$

For the production casing in Cymric 1Y project, the casing temperature increase is about 386 deg. F (from 119 deg. F of initial/undisturbed casing temperature to 505 deg. F at steam injection 60 hrs, as shown in Fig. 4) at the primary production casing failure location (around the surface casing shoe), and the casing thermal axial compressive stress is then calculated as

$$\Delta\sigma = -6.9*10^{-6}*30*10^{6}*(505-119) = -79{,}902 \text{ psi}$$

This thermal axial compressive stress exceeds the reduced casing yield strength (66,114 psi) at the corresponding temperature (505 deg. F) for the L-80 grade production casing, and can cause the production casing yield under the thermal axial compressive stress (hot-yield) at that location:[2]

$$\sigma_y \text{ (at 505 deg. F)} = 80{,}000*(1-(505-100)/2333.3) = 66{,}114 \text{ psi}$$

When the L-80 grade production casing in Cymric 1Y project is hot-yielded at the primary production casing failure location (around the surface casing shoe depth) under the thermal axial compressive stress in steam injection period, the casing resistance to collapse pressure should be significantly reduced and the casing could be easily collapsed by a small external pressure. The casing external pressure may come from annulus trapped pressure or casing-cement contact pressure from thermal radial expansions of casing and formation as temperature increases.[3] Casing-cement contact pressure induced from thermal radial expansions may also damage the cement and make casing collapse becomes even easier under a resultant non-uniform external pressure condition. Severe casing buckling and deformation may also occur once cement is damaged, when casing is under high thermal axial compressive load.

Figure 5 illustrates the hot-yield of the 7" production casing in Cymric 1Y project, where the triaxial safety factor is shown less than 1.0 for the top ~620 ft casing section and the casing loading line is located outside the casing VME yield ellipse for the same casing section. A small external pressure from annulus trapped pressure or casing-cement contact pressure by thermal radial expansions of casing and formation is therefore to collapse the casing as indicated. Although no casing hot-yield occurs at the secondary casing failure location (around the perforation depth ~1200 ft) by calculation, the observed casing failures at that location may be related to a possible damage of cement due to perforation, production, and casing-cement contact pressure by thermal radial expansions of casing and formation, causing casing buckling under thermal axial compressive load and casing collapse under non-uniform external pressure condition.

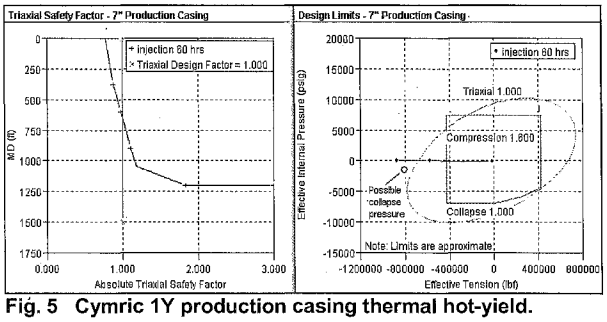


Fig. 5 Cymric 1Y production casing thermal hot-yield.

2. Casing Fatigue

Besides casing hot-yield and the resultant casing collapse failure, casing fatigue failure may also occur in cyclic steam-injection operation wells. We know that casing temperature increases in steam-injection period and reduces in the soak period in cyclic steam-injection operation, as shown in Fig. 4. Casing can be hot-yielded in thermal axial compression in steam-injection period and become under axial tensile stress in soak period, depending on the degree of casing temperature change in steam and soak periods. This alternation of casing axial compressive and tensile stresses can result in casing fatigue failure, especially at casing connection due to stress concentration.

For the cyclic steam-injection operation in Cymric 1Y project, the casing temperature at the primary production casing failure location (the surface casing shoe depth) is modeled to be about 505 deg. F at the end of steam-injection and about 209 deg. F at the end of soak, as shown in Fig. 4. The corresponding 7" production casing axial stress in the first cycle of steam injection is roughly illustrated in Fig. 6, where a perfect-plasticity of casing material is used to simplify the stress-strain relationship of steel casing plasticity. It is seen that casing pipe body is hot-yielded under thermal axial compressive stress in steam period, but does not develop axial tensile stress in soak period due to a relatively high soak temperature (209 deg. F). However, due to stress concentration, a local tensile yield is developed at casing connection (last pin thread) in soak period as shown in Fig. 6. The local hot-yield at the connection is also developed much earlier than on casing pipe body in the steam injection period due to stress concentration. On the subsequent cycles of steam injection operation, the local yielding at casing connection under compressive and tensile stresses will be repeated, and will result in casing fatigue failure at connection. This stress concentration effect may also be applied to any casing body imperfections and cause casing fatigue at such locations. A common stress concentration factor 3.50 at casing connection is used here to develop Fig. 6.

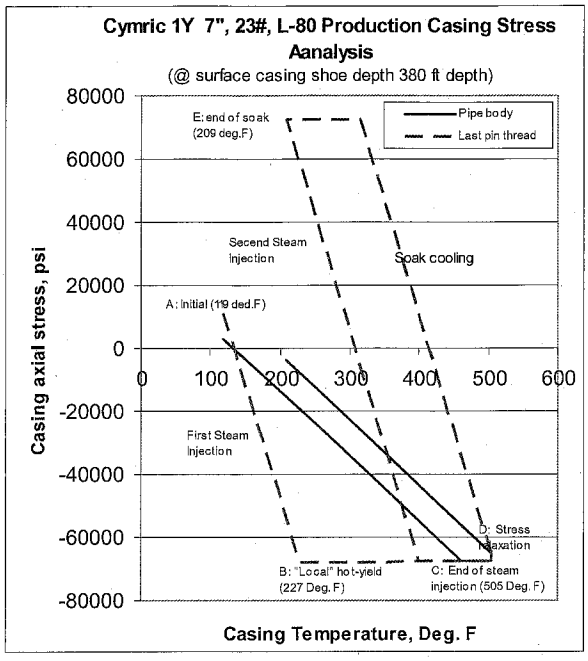


Fig. 6 Casing thermal stress profiles (stress concentration factor 3.50 at connection).

The local stress-strain response at casing connection due to stress concentration, different from the nominally induced casing pipe body thermal axial stress, is similar to what was pointed out in a metal fatigue textbook[4] on "notched" materials, as shown in Fig. 7, where the nominally applied stress (S) is all in tensile stress, while the local stress-strain (σ) response at the notch (hole) is completed reversed (tensile and compressive) due to residual stress developed as a result of local yielding at the notch root.

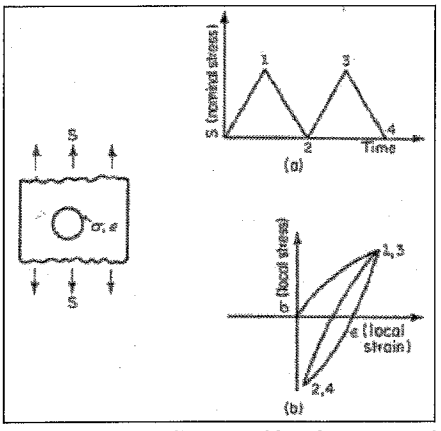


Fig. 7 Completed reversed local stress-strain response.[4]

There are generally three basic methods on fatigue analysis: (1) the stress-life method to determine the fatigue life of a smooth specimen subjected to an alternating stress. This method may also be used for high cycle fatigue of notch specimen where the notch strains are predominantly elastic. (2) the strain-life method which is developed to account for notch root plasticity and the influence of local sequence effects on local mean and residual stresses. (3) Fracture mechanics to account for fatigue crack growth at a notch, which allows estimation of the propagation portion of fatigue life. The strain-life method will be used in this paper to analyze casing fatigue at casing connection in cyclic steam-injection operation wells, as large plasticity at the connection (last pin thread) is seen in Fig. 6.

The following strain-life Manson equation[5] (Eq. 3) can be used to estimate the low-cycle fatigue life at casing connection in cyclic steam injection operation. It relates the fatigue life (cycles) to the total cyclic strain change, and simply indicates that the material properties of tensile strength (S_u), Young's modulus (E), and true fatigue strain (ε_f), which can be obtained from a monotonic tensile test, are the main variables to control the low-cycle fatigue.

$$\Delta\varepsilon_t = 3.5\frac{S_u}{E}(N)^{-0.12} + \varepsilon_f^{0.6}(N)^{-0.6} \qquad (3)$$

Figure 8 and 9 are the plotted strain-life curves developed by using Manson equation with varying material tensile strength (S_u) and true fatigue strain (ε_f) on L-80 grade of casing material. No significant change is however seen to the fatigue life on the plotted range of the variables, though casing material (grade) with good ductility (larger ε_f) and high strength (larger S_u) can have longer fatigue life.

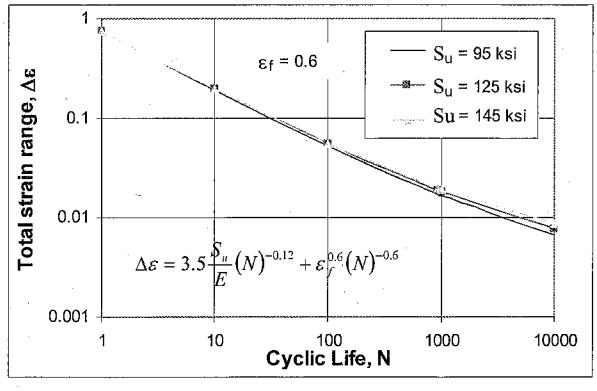


Fig. 8 Effect of material tensile strength on fatigue life.

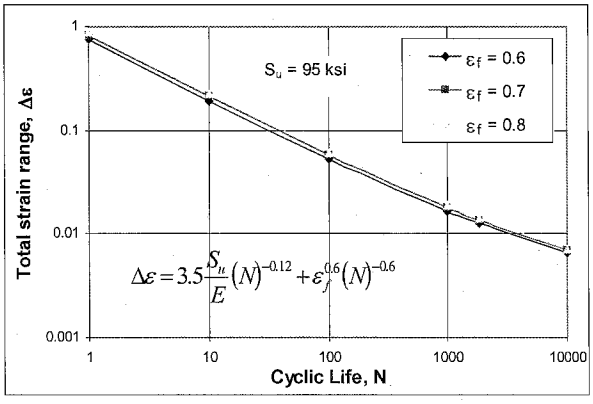


Fig. 9 Effect of true fatigue strain on fatigue life.

Now, we need to determine the local cyclic strain change at the casing connection in cyclic steam injection operation, and then use the Manson equation to predict casing fatigue at connection. Generally, the total cyclic strain change may be obtained from (1) Strain gage measurements, (2) Finite element analysis, and (3) Methods that relates local stress and strain to nominal values. We will use the third approach to estimate local cyclic strain change at the casing connection in this paper.

For cyclic steam-injection operation, the cyclic nominal strain on casing pipe body can be estimated directly by the casing temperature change between steam injection and soak periods. As shown in Fig. 6 for the Cymric 1Y project, the casing temperature change at the primary casing failure location is roughly between 505 deg. F at steam injection and 209 deg. F at soak, and the cyclic nominal strain on casing pipe body can then be estimated as

$$\Delta\varepsilon_p = -6.9*10^{-6}*(209 - 505)*3.5 = 0.002$$

If we directly apply the stress concentration factor to this cyclic nominal strain on casing pipe body to estimate the total cyclic strain change at casing connection, we will not get the correct value on the total cyclic strain change at casing connection due to the thread (notch) root plasticity. The theoretical stress concentration factor (K_t), used to relate the nominal stress (S) to the local stress (σ) and the nominal strain (e) to local strain (ε), remains constant until yield begins. Upon yielding ($\sigma/\sigma_y > 1$), the local stress (σ) and local strain (ε) are no longer related to the nominal values by theoretical stress concentration factor K_t. Instead, local values are related to the nominal values in terms of stress and strain concentration factors, where the stress concentration factor K_σ decreases with respect to K_t and the strain concentration factor K_ε increases respect to K_t, as shown in Fig. 10.

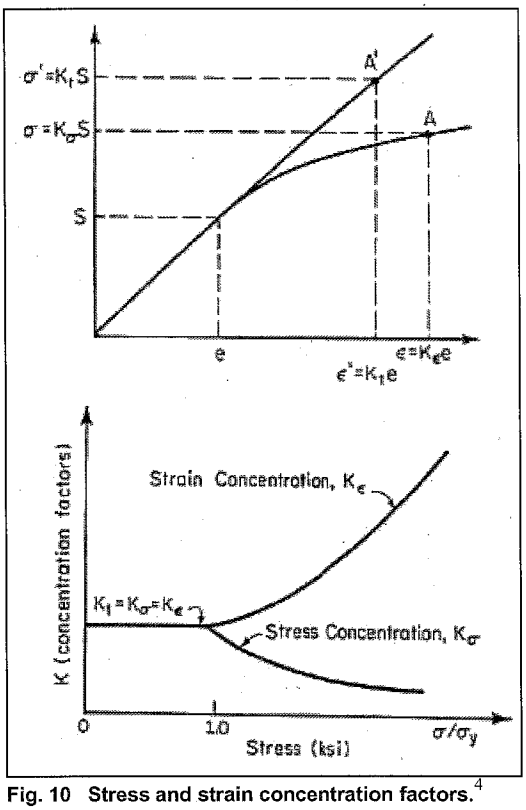


Fig. 10 Stress and strain concentration factors.[4]

Therefore, as the plastic yielding occurs at casing connection (last pin thread) in the cyclic steam injection operation at the Cymric 1Y project (Fig. 6), the total cyclic strain change at casing connection ($\Delta\varepsilon_t$) will be larger than the product of the theoretical stress concentration factor K_t and the thermal strain change on casing pipe body $\Delta\varepsilon_p$ (based on 505 deg. F at steam injection and 209 deg. F at soak):

$$\Delta\varepsilon_t > K_t\Delta\varepsilon_p = -6.9*10^{-6}*(209 - 505)*3.5 = 0.007$$

The total cyclic strain change at casing connection (last pin thread) may be more accurately modeled through Finite Element Analysis (FEA), or estimated through notch stress-strain behavior equations, such as the following Eqs. 4 and 5 developed by elastic-plastic form of Neuber's rule[4], that relates the change of local stress ($\Delta\sigma_t$) and strain ($\Delta\varepsilon_t$) to the nominal values:

$$\Delta\varepsilon_t = \frac{\Delta\sigma_t}{E} + 2\left(\frac{\Delta\sigma_t}{2K'}\right)^{1/n'} \quad (4)$$

$$\frac{(K_f\Delta S_t)^2}{2E} = \frac{(\Delta\sigma_t)^2}{2E} + \Delta\sigma_t\left(\frac{\Delta\sigma_t}{2K'}\right)^{1/n'} \quad (5)$$

For the L-80 grade casing used in Cymric 1Y project, casing material cyclic strength coefficient (K') and cyclic

strain hardening exponent (n') in the above notch stress-strain behavior equations are estimated as 155,700 psi and 0.14, by the following correlations:[4]

$$K' = \frac{\sigma_f'}{(\varepsilon_f')^{n'}} \quad (6)$$

$$n' = \frac{b}{c} \quad (7)$$

With b = -0.085, c = -0.6, σ_f' = S_u + 50 psi, S_u = 95 psi, and ε_f' = 0.6.

The total cyclic change of local stress ($\Delta\sigma_t$) and strain ($\Delta\varepsilon_t$) at the connection (last pin thread) at the primary casing failure location in Cymric 1Y project can then be calculated out from Eqs. 4 and 5, with the total cyclic change nominal stress at casing pipe body ΔS = 62,000 psi (from Fig. 6), casing Young's modulus E = 30,000,000 psi, casing connection fatigue notch factor K_f = 3.5, casing material cyclic strength coefficient K' = 155,700 psi, and cyclic strain hardening exponent n' = 0.14:

$$\Delta\sigma_t = 152{,}100 \text{ psi}$$

$$\Delta\varepsilon_t = 0.017$$

Using the strain-life Manson equation (Eq. 3) with S_u = 95,000 psi, E=30,000,000 psi, ε_f = 0.60, a fatigue life of about 930 (cycles) is predicted, for L-80 grade casing to the estimated total cyclic change of local strain $\Delta\varepsilon_t$ = 0.017.

This predicted fatigue life (930 cycles) is higher than what was observed in the Cymric 1Y project (about 80 cycles, Fig. 2), which may be due to some factors that would increase the total cyclic change of local strain at casing connection and/or body imperfections, such as casing buckling and/or a higher casing connection fatigue notch factor K_f, are not considered in the above analysis. If the total cyclic change of local strain at casing connection would be increased to 0.053, the L-80 grade production casing fatigue life would be predicted by Manson equation (Eq. 3) at only 100 cycles of steam injection operation under Cymric 1Y project condition.

Recommendations and Conclusion

From modeling casing temperature and analyzing casing thermal stress/strain, hot-yield, and casing fatigue in steam injection wells, the following conclusions may be drawn regarding casing design in steam injection wells:

1. Production casing is usually hot-yielded in steam injection wells due to high thermal axial compressive stress. Casing collapse resistance reduces when casing hot-yielded and casing can easily be collapsed under small external pressure, which can be present as annulus trapped pressure and/or casing-cement contact pressure from thermal radial expansions of casing and formation at steam injection period. Higher strength grade casing (such as 110 grade) may be used to help reduce casing hot-yield and the related casing collapse failure. The use of P-110 grade production casing in Cymric 1Y project after 2002 has shown a significant reduction of casing failures.
2. Casing failure can also occur by fatigue in cyclic steam injection wells at casing connection (last pin thread) and casing pipe body imperfections with stress/strain concentration, due to the local axial thermal compressive and tensile stress/strain alternation between steam and soak periods. Casing material (grade) with good ductility and high strength needs to be used for a better (longer) fatigue life, as shown by Fig. 8 and 9 (the higher the material true fatigue strain ε_f and the material tensile strength S_u, the longer the fatigue life of casing).
3. Setting deeper surface casing may help reduce production casing failure in steam injection wells, as it can reduce the production casing temperature elevation and then casing hot-yield and the related collapse failure near the surface casing depth location. It can also reduce the production casing temperature alternation and then the total local strain change and the related fatigue failure near the surface casing depth location in cyclic steam injection operation.
4. Further investigation may be needed on the effect of casing buckling on casing fatigue in cyclic steam injection wells.

Nomenclature

b = Fatigue strength exponent,
c = Fatigue ductile exponent,
e = Nominal strain
E = Casing Young's modulus, 30,000,000 psi for steel
K_f = Casing connection fatigue notch factor,
K_t = Casing connection stress-strain concentration factor
K_σ = Casing connection stress concentration factor,
K_ε = Casing connection strain concentration factor,
K' = Casing material cyclic strength coefficient, psi
n' = Cyclic strain hardening exponent
N = Number of stress/strain cycle
S = Nominal stress, psi
S_u = Casing tensile strength, psi
ΔS_t = Total cyclic change of nominal stress, psi
ΔT = casing temperature increase, Deg. F
α = Casing thermal expansion coefficient, 0.0000069/deg. F for steel

σ = Local stress, psi
σ'_f = Casing fatigue strength coefficient, psi
σ_y = Casing yield strength, psi
$\Delta\sigma$ = Casing thermal axial stress, psi
$\Delta\sigma_t$ = Total cyclic change of local stress, psi
ε = Local strain
ε_f = True fatigue strain
ε'_f = Fatigue ductile coefficient
$\Delta\varepsilon$ = Casing thermal axial strain
$\Delta\varepsilon_p$ = Total cyclic change of nominal strain
$\Delta\varepsilon_t$ = Total cyclic change of local strain

Acknowledgements

The authors would like to thank Chevron management for permission to publish this paper.

References

1. Wu, Jiang and et al: "Steam Injection Casing Design", SPE 93833 presented at the 2005 SPE Western Regional Meeting held in Irvine, CA, U.S.A., 30 March – 1 April 2005
2. Chevron Casing Design Manual, 2005
3. Wu, Jiang and et al: "Casing Temperature and Stress Analysis in Steam-Injection Wells", SPE 103882 presented on 2006 SPE International Oil & Gas Conference and Exhibition in Beijing, China, Dec. 5-8, 2006
4. Bannantine, A. Julie and et al: "Fundamentals of Metal Fatigue Analysis", Prentice-Hall Inc., 1990
5. Fuchs, H.O. and Stephens, R.I.: "Metal Fatigue in Engineering", John Wiley & Sons, Inc., 1980
6. Willhite, G. Paul and et al: "Design Criteria for Completion of Steam Injection Wells", JPT, January 1967.
7. Lepper, G.B.: "Production Casing Performance in a Thermal Field", JCPT, Sept. 1998.
8. Maruyama, K. and et al: "An Experimental Study of Casing Performance under Thermal Cycling Conditions", SPE Drilling, June 1990.
9. Kaisei, T.M.V. and et al: "Cyclic Mechanic and Fatigue Properties for OCTG Materials", SPE/PS-CIM/CHOA 97775 presented on 2005 International Thermal Operations and Heavy Oil Symposium in Calgary, Canada, Nov. 1-3, 2005.
10. Dall'Aacqua, D. and et al: "Post-Yield Thermal Design Basis for Slotted Liner", SPE/PS-CIM/CHOA 97777 presented on 2005 International Thermal Operations and Heavy Oil Symposium in Calgary, Canada, Nov. 1-3, 2005.

From: dave@watsonplanning.us
To: Comments@DOC
Cc: Henry Warshaw; naherns@vrellc.com
Subject: Freeport-McMoRan AQUIFER EXEMPTION
Date: Tuesday, December 15, 2015 12:17:47 PM
Attachments: top.letterhead
FREEPORT-PXP DOGGRComments 12-15-2015.pdf

Attached are additional comments on this pending application.

David Watson, AICP
WATSON PLANNING CONSULTANTS
Post Office Box 385
Pismo Beach, California 93448-0385
Tel: 805.704.8728
Em: dave@watsonplanning.us
Em: planningconsults@aol.com
Website: www.watsonplanning.us

WATSON PLANNING CONSULTANTS

Land Use Planning and Real Estate Development
Solutions and Services Since 1989

Post Office Box 385
Pismo Beach, California 93448
Telephone 805.704.8728
www.WatsonPlanning.us
Dave@WatsonPlanning.us
PlanningConsults@aol.com

December 15, 2015

California Department of Conservation
Division of Oil, Gas and Geothermal Resources
ATTN: Aquifer Exemption
Proposed Freeport-McMoRan Arroyo Grande Oilfield, San Luis Obispo County
801 K Street, MS 24-02
Sacramento, CA 95814

Re: 2nd Round of Comments Concerning PROPOSED AQUIFER EXEMPTION - Freeport-McMoRan (formerly PXP)
Oil Well Operations – 1821 Price Canyon Road, San Luis Obispo, CA

Sir or Madam:

Please accept this follow-up letter on behalf of my clients, the owners of the property adjoining and to the immediate southwest of the Freeport-McMoRan Oil and Gas (FMO&G) property at 1821 Price Canyon Road. We submitted initial correspondence dated September 23, 2015, requesting an exemption area boundary monitoring and reporting requirement.

1 The proposed expansion of the aquifer exemption adjoining my client's property is significant, and could represent a potential contaminant to the groundwater supplies we rely on for the vineyard and residential sites, and for this reason we again request a specific program be delineated that we can specifically review and comment on that addresses these concerns. Previous indications from Water Quality staff suggest such a program may be required, but to date nothing specific has been offered that would allow us to evaluate or comment.

We, again, appreciate the opportunity to raise these concerns. We respectfully ask that you outline your preliminary findings/recommendations with specific locations for monitoring-sentry wells along our common boundary, and a monitoring protocol so that we can be assured our interests are protected.

Sincerely,

David Watson, AICP
WATSON PLANNING CONSULTANTS

cc: Henry Warshaw, VRE

From: Carol Florence
To: Comments@DOC
Subject: NOTICE OF PROPOSED AQUIFER EXEMPTION
Date: Wednesday, December 16, 2015 11:48:53 AM
Attachments: 2015-12-15.AEVGResponsetoDOGGRetalProposedAquiferExemption.pdf
Importance: High

Mr. Tim Shular, et al.

Attached is correspondence from the Association of Edna Valley Growers, County of San Luis Obispo with regards to the subject project. Thank you, on their behalf, for accepting and distributing the comments, accordingly.

Respectfully,

C.M. Florence, AICP
Principal Planner

OASIS ASSOCIATES, INC.
LANDSCAPE ARCHITECTURE + PLANNING
3427 Miguelito Ct., San Luis Obispo, CA 93401
P: 805.541.4509 | F: 805.546.0525 | C: 805.459.9972
www.OASISASSOC.com

15 December 2015

DEPARTMENT OF CONSERVATION
801 K Street, MS 24-02
Sacramento, CA 95814

via email – comments@conservation.ca.gov

RE: PROPOSED AQUIFER EXEMPTION DESIGNATION– DOLLIE SANDS, PISMO BEACH FORMATION, ARROYO GRANDE OIL FIELD, COUNTY OF SAN LUIS OBISPO

To whom it may concern,

On behalf of the Association of Edna Valley Growers ("Growers") – an organization comprised of landowners and agriculturists cultivating the valley's vineyards, orchards, and row crops, this correspondence represents their written statement of support relevant to the aforementioned action.

We have availed ourselves of the Public Notice and all documents related to the proposed aquifer exemption application. In addition, we are encouraged that the ultimate approval of the project and permits will involve a joint review by the Division of Oil, Gas and Geothermal Resources, the State Water Board, and importantly for us, our Regional Water Quality Control Board.

In addition to the safeguards inherent in the permitting process, we can support the aquifer exemption based upon the following technical considerations:

- The subsurface hydraulic connection between the Edna sub-basin and Price Canyon water bearing zones is restricted by faulting and folding, which act as barriers to groundwater flow; and that
- The reservoir is bounded by the Arroyo Grande Fault and multiple fault splays north of the main fault. This fault and its splays provide a seal to fluid or steam migration northward from the oilfield.

Thank you for the opportunity to provide you with the Grower's comments regarding this important action. Please contact me directly @ 808.541.4509/cmf@oasisassoc.com should you have questions or should you require any additional information.

Respectfully,
OASIS ASSOCIATES, INC.

C.M. Florence, AICP Agent
ASSOCIATION OF EDNA VALLEY GROWERS

c: AEVG
15-0128

From:	Mary Ciesinski
To:	Comments@DOC
Subject:	ECOSLO Public Comments - Proposed Aquifer Exemption in the Arroyo Grande Oilfield
Date:	Tuesday, December 15, 2015 11:18:07 AM
Attachments:	2015.12.15_ECOSLO-Public-Comment-Aquifer.pdf

Please see attached letter. Thank you,
Mary

Mary A. Ciesinski, Executive Director
ECOSLO - Environmental Center of San Luis Obispo
Phone: (805) 544-1777
Email: mary@ecoslo.org
www.ecoslo.org | find us on facebook

Office: 246 S. Higuera St.
San Luis Obispo, CA 93401
Mail: PO Box 1014
San Luis Obispo, CA 93406

EcoSlo
ENVIRONMENTAL CENTER
OF SAN LUIS OBISPO

Phone: (805) 544-1777
Email: info@ecoslo.org
Online: www.ecoslo.org

Protecting and enhancing the Central Coast since 1971

Mr. Tim Shular
Department of Conservation
ATTN: Aquifer Exemption
801 K Street, MS24-02
Sacramento, CA 95814

RE: Public Comment on the Proposed Aquifer Exemption in the Arroyo Grande Oilfield

Dear Mr. Schular,

The Environmental Center of San Luis Obispo County (ECOSLO) has comments regarding the Proposed Aquifer Exemption in the Arroyo Grande Oilfield. Our focus since we were founded in 1971 is on enhancing and protecting our beautiful, natural environment. ECOSLO is well known for advocating important issues, supporting trail work days, leading guided hikes, organizing beach cleanups, and for being a center for environmental issues and causes.

ECOSLO and its membership oppose the exception to the federal Safe Drinking Water Act. The applicant has failed to prove that the boundaries of the proposed expanded exemption area are impenetrable and will not affect other contiguous drinking water sources.

Water is life. Water is a very precious resource, especially in California. We can not take chances on this limited resource. The responsibility must be on the applicant/developer to prove their actions will do no harm to aquifers or the environment.

No contingency or emergency plan is included in the application or the presentation by Freeport-McMoRan. These types of infrastructure projects are capable of failure from man made and/or natural disasters. In this case the consequences could be catastrophic to the watershed and aquifers (including aquifers covered by the Sustainable Groundwater Management Act). Failure to plan is a plan to fail.

Other oil developers in San Luis Obispo have left huge environmental disasters (ie: Avila Beach, Tank Farm and Guadalupe) costing millions of dollars in cleanup costs and compromising fragile ecosystems. San Luis Obispo County cannot afford to take chances with its limited water supplies.

For these reasons, myself and the ECOSLO Board of Directors, on behalf of our members and supporters, respectfully request the Department of Conservation deny the proposed exemption.

Sincerely,

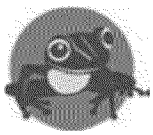
Mary A. Ciesinski
ECOSLO Executive Director

From: Laura McCamy
To: Comments@DOC
Cc: Maya Golden-Krasner
Subject: Amended supplemental comments on Arroyo Grande Aquifer Exemption
Date: Wednesday, December 16, 2015 5:27:32 PM
Attachments: image001.png
15 12 16 CBD Amended Comments AGOF Supplemental AE.pdf

Dear Department of Conservation,

Attached please find the Center for Biological Diversity's amended supplemental comments on the Arroyo Grande Aquifer Exemption Application.

Laura McCamy
Climate Law Institute Paralegal
CENTER FOR BIOLOGICAL DIVERISTY
1212 Broadway, Suite 800
Oakland, CA 94612
Phone (510) 844-7154
lmccamy@biologicaldiversity.org



CENTER for BIOLOGICAL DIVERSITY Because life is good.

December 16, 2015

via electronic mail and U.S. mail to:

Department of Conservation
ATTN: Aquifer Exemption
801 K Street, MS 24-02
Sacramento, CA 95814
comments@conservation.ca.gov

Re: Freeport-McMoRan Oil & Gas, LLC, Arroyo Grande Oil Field Aquifer Exemption--Dollie Sands, Pismo Formation

To Whom It May Concern,

The Center for Biological Diversity ("the Center") submits this second round of comments in opposition to the recommendation of the Department of Conservation, Division of Oil, Gas and Geothermal Resources ("DOGGR") to exempt the Arroyo Grande Oil Field ("AGOF") aquifer in order to allow Freeport-McMoRan ("FMOG") to inject oil wastewater into the aquifer. Under federal law, the US EPA may not approve an aquifer exemption if it is currently or could be used as a source of drinking water.[1] Under state law, DOGGR and the State Water Resources Control Board ("State Water Board") cannot exempt an aquifer that will affect any water used for "beneficial" uses—defined broadly—or is not isolated from other groundwater.[2] The Center's first round comments, incorporated by reference, showed that FMOG's application failed to meet the legal requirements for exempting an aquifer under both federal and state law for the following reasons.

- The historic drought has prompted mandatory water restrictions; the drilling of new water wells deeper and tapping into previously unused aquifers; and the serious consideration

[1] 40 C.F.R. § 146.4.
[2] Cal. Pub. Res. Code §§ 3131(a)(2), (3).

Alaska · Arizona · California · Florida · Minnesota · Nevada · New Mexico · New York · Oregon · Vermont · Washington, DC
Maya Golden-Krasner, Climate Staff Attorney · P.O. Box 1476 · La Cañada Flintridge, CA 91012
Phone: 213-215-3729 · Fax: 510-844-7150 · mgoldenkrasner@biologicaldiversity.org

of using alternative water purification technologies.[3] For these reasons, the state and federal government must take a hard look at whether they are truly willing to sacrifice water supplies with potential beneficial uses (such as, here, where aquifer water is sent to Pismo Creek) or that could affect or be used as domestic water supplies, for the convenience of the oil industry, in violation of state and federal law.

- The proposed exemption is tied to a massive expansion of oil operations at AGOF, which will affect pressure, groundwater flow, and zonal isolation, in addition to the potential for increasing seismic risk and subsidence. These operations will also vastly increase the waste water produced at the site.[4] DOGGR, the State Water Board, and US EPA cannot approve the exemption until a full analysis of the hydrology under these conditions has been performed to demonstrate hydraulic isolation, including isolation from current and potential sources of drinking water. It has not been performed here.
- Similarly, FMOG has not presented a detailed analysis of the toxicity of the water it uses for steam injection or waste water disposal; nor has it provided an analysis of the effects its gas injection has on the pressure (hence, groundwater flow) of the AGOF.
- The burden is on FMOG to prove that the aquifer is not currently used for drinking water, and that it will not affect drinking water or beneficial use water; the presumption is in favor of protecting aquifers.[5] Even without the planned expansion, FMOG failed to provide adequate information to prove this.

Nothing in the new documentation provided by DOGGR does anything to change the fact that FMOG has not provided the necessary information to prove the aquifer is isolated and/or that injection of drilling wastewater will not affect beneficial use or drinking water. What is

1

[3] Center for Biological Diversity, Comments on the Arroyo Grande Oil Field Aquifer Exemption Application (September 21, 2015) ("CBD, Sept. 21 Aquifer Exemption Comments"), pp. 3-4; Center for Biological Diversity, Comments to San Luis Obispo Planning Commission re: Freeport-McMoRan Oil & Gas, LLC, Arroyo Grande Oil Field, Application to Extend Phase IV CUP # D010386D (October 21, 2015) ("CBD, Oct. 21, 2015 CUP Phase IV Extension Comments"), pp. 4-5; Center for Biological Diversity, Appeal from Planning Commission Decision on November 12, 2015 to San Luis Obispo County Supervisors File Number DRC20150002 (November 25, 2015) and attached letter from Matt Hagemann (together, "CBD, Nov. 25, 2015 Appeal"), pp. 4. All of these documents are attached and incorporated in their entirety herein.

[4] CBD, Sept. 21 Aquifer Exemption Comments, pp. 9-12.

[5] 40 C.F.R. § 144.12; 40 C.F.R. §§ 144.7(a), (b); *United States v. King*, 660 F.3d 1071, 1079 (9th Cir. 2011). *See* CBD, Sept. 21 Aquifer Exemption Comments, pp. 5-8, 14.

more, despite repeated requests from the nearby residents and the Center, and despite an order from the Central Coast Regional Water Quality Control Board ("Regional Board"), FMOG has consistently refused to provide critical information, such as accurate nearby water well locations, depth and samples, or a numerical groundwater flow model,[6] which are critical to demonstrating that this aquifer meets the criteria set forth in state and federal law. For these reasons and the reasons set forth below, DOGGR and the US EPA must deny the exemption request. In particular, the new information provided raises only more concerns about the integrity of the "boundaries" of the aquifer, the lack of data about nearby wells, and the use of antiquated criteria to legitimize currently illegal injection activity. Additionally, data from the California Air Resources Board demonstrates that this oil field is extremely water and carbon intensive to produce, which raises policy concerns about the utility of sacrificing California's groundwater to an increasingly inefficient oil field during a time when water is at a premium and the climate is at risk.

2

FMOG's Hydraulic Analysis Remains Woefully Inadequate; It Does Not Demonstrate Isolation from Drinking Water or Beneficial Use Water.

The documentation supporting FMOG's application reveals its best guess as to whether the proposed exemption area is isolated from drinking water and other potential water supplies. Its best guess, however, is not good enough to overcome the presumption in favor of protecting groundwater, especially in a time of extreme drought. Additionally, it is not necessary for the public to cross its fingers and rely on a "best guess"; FMOG could, in fact, conduct the proper tests and evaluations of the aquifer. For instance, FMOG should provide, and the agencies should require, a numerical groundwater model to map and analyze groundwater flow under various

3

[6] *See, e.g.*, CBD, Sept. 21 Aquifer Exemption Comments, pp. 12-20; Center for Biological Diversity, Comments to San Luis Obispo Planning Commission re: Freeport-McMoRan Oil & Gas, LLC, Arroyo Grande Oil Field, Application to Extend Phase IV CUP # D010386D--Supplemental Information (Nov. 11, 2015), pp. 3-4, and attached letter from Matt Hagemann (together, "CBD Nov. 11, 2105 Supplemental CUP Phase IV Extension Comments," incorporated in its entirety); CBD, November 25, 2015 Appeal, pp. 5-8; Central Coast Regional Water Quality Control Board, Order Pursuant to California Water Code section 13267 ("13267 Order") (May 14, 2015); FMOG's inadequate and incomplete response to this order can be found at http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000006979. *See also*, Natural Resources Defense Council, *Aquifer Exemption Comments*, September 21, 2015 ("NRDC Comments,") p. 8 (noting that application fails to adequately identify groundwater flow directions or how pumping activities affect the hydraulic gradient, and that the application fails to provide the necessary well data for nearby water supply wells, including depth, status, and use of the wells).

pumping and injection conditions. FMOG should provide, and the agencies should require, detailed information about water wells within one mile of the proposed exempted area. Instead, FMOG and the agencies rely on vague, anecdotal, and inferred evidence to assert that the aquifer is not hydraulically connected to nearby water wells, and that the aquifer's boundaries are nearly impermeable.

3

The federal regulations require that FMOG demonstrate that the aquifer does not or cannot now or in the future be used as a source of drinking water because it is: (1) hydrocarbon producing or contains hydrocarbons that are commercially producible, (2) it is situated at a location or depth that makes it economically or technologically impractical to use for drinking water, or (3) it is so contaminated that it would be economically or technologically impractical to drink it.[7] Alternatively, an aquifer can receive an exemption if (4) the TDS is over 3,000 and it is not reasonably expected to supply a public water system.[8] Here, DOGGR and the US EPA have already stated that it is not hydrocarbon bearing, so (1) does not apply, and it is under 3,000 mg/L TDS, so (4) cannot apply. In June 2015, DOGGR wrote in a letter to FMOG:

4

> The reported injection zone water (receiving water) is less than 3,000 mg/L TDS, and although much of the area that is request for exemption is hydrocarbon producing, there are portions of the requested exemption area that are no longer productive. USEPA staff has recently stated verbally that, unless the injection is for enhanced oil recovery (EOR) purposes, an aquifer exemption for aquifers with less than 3,000 mg/L TDS is very difficult to justify. To support an aquifer exemption proposal in these areas, strong documentation is needed to indicate: 1) the proposed aquifer exemption area is situated at a depth or location which makes recover of water for drinking water purposes economically or technologically impractical and/or 2) it is so contaminated that it would be economically or technological impractical to render that water fit for human consumption. In addition, documentation is needed to indicate that the proposed exempted portion of the formation is sufficiently isolated such that injection would not pose a threat to the portion of the aquifer with existing beneficial uses.[9]

Thus, FMOG cannot rely on the "hydrocarbon-bearing" or "over 3,000 mg/L TDS" criteria to exempt its aquifer, and must instead assert that the aquifer is not and cannot be used for drinking

[7] 40 C.F.R. §§ 146.4(a), (b).
[8] 40 C.F.R. §§ 146.4(c).
[9] Letter from Patricia Abel, District Deputy, DOGGR, to Kenneth R. Bork, Agent, Freeport-McMoRan Oil & Gas, LLC Re: Arroyo Grande Oil Field, Aquifer Exemption, Dollie Zone of Pismo Fm (June 8, 2015) ("DOGGR, June 8, 2015 Letter"), p. 3.

4 water, and that it will not threaten nearby groundwater with beneficial uses. FMOG cannot meet these criteria.

First, FMOG cannot show that the water is sufficiently isolated so as not to affect beneficial use groundwater. For example, the Statement of Basis relies on the fault that forms the northern boundary to restrict water flow, but provides no supporting pump tests or aquifer tests. Given that there are water wells directly adjacent to aquifer exemption boundary created by the fault, these tests, in addition to a numerical groundwater model, are critical to protecting these wells' water.[10] The Statement of Basis also asserts that the Miguelito Member forms a layer of protection from drinking water wells.[11] However, the Miguelito Member forms the bottom of the alleged synclinal bowl that underlies the Edna Member. It cannot, therefore, serve as a barrier between the wells in the exempt area and water wells completed in the Edna Member.[12] In fact, there are six wells that are themselves completed in the Miguelito Member, suggesting it is an aquifer rather than an aquitard.[13] Furthermore, FMOG and DOGGR place great emphasis on the tar seal providing a hydraulic barrier that would prevent drinking water from being contaminated by FMOG's injection into this aquifer. The permeability and even existence of the tar seal at the locations depicted in cross section B to B', however, is inferred at best,[14] and the public should not be forced to rely on FMOG's and the agencies' sincerest hope that these inferences are correct.[15]

---

[10] Matt Hagemann, PG, C. Hg., Comments on the Arroyo Grande Aquifer Exemption Application (Dec. 14, 2015) ("Hagemann, Dec. 14, 2015 Aquifer Exemption Comments," Attachment A), pp. 3 (map) & 4.
[11] Statement of Basis, p. 6.
[12] Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, p. 4.
[13] *Ibid.*; NRDC Comments, p. 16, further describing the discontinuities in the Miguelito Member.
[14] FMOG, Aquifer Exemption Application, Appendix A7a2; Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, p. 5. *See also* NRDC Comments, p. 17 ("Both publications from DOGGR [1944 and 1958 showing the location and distribution of tar sands] occur in discrete and discontinuous deposits that outcrop at various locations throughout the field....").
[15] Mr. Hagemann notes that in addition to concerns that water from the exempted aquifer will pollute nearby wells, there are real, unanswered concerns about the potential for the dewatering project to draw adjacent water inward: "the inward gradient may induce flow of groundwater across the fault boundary and across any hydraulic boundary that is represented by the tar sands. . . in light of the amount of water that is removed from the oil field, a condition known as dewatering. Since approval of the Project, aquifer dewatering has been actively pursued by the applicant. . . . The dewatering lowers hydraulic pressure and creates a 'sink,' according to the applicant. The impact of this pressure sink on inducing flow from adjacent drinking water resources and across the exemption boundaries as not been evaluated and should be tested using aquifer tests and numeric model." Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, pp. 4-5.

Second, FMOG cannot demonstrate that the water is not or cannot be used for domestic water. Indeed, at least 24 wells are known to have been completed in the Edna Member of the Pismo Formation, the same geologic unit that is proposed for exemption.[16] Many of these are just "outside" the inferred tar seal.[17] The Statement of Basis notes that none of the water supply wells are located in the Dollie Sands,[18] but this assertion is misleading and a red herring; the Dollie Sands are part of the Edna Member and are not a recognized separate geologic unit or formation.[19] Indeed, despite the fact that at least 24 wells draw from the same water bearing unit at similar depths, FMOG has not presented any geologic cross sections that would depict the relationship of drinking water wells to the injection wells or production wells. While the scale of the aerial map provided in the "new" information supporting the exemption request is too large to precisely identify the location of nearby water wells, it is clear that water wells within several hundred feet of the proposed exemption boundary draw water from the Edna Member at similar depths as that which injection occurs.[20] At the very least, therefore, FMOG *must* provide *specific* latitudinal and longitudinal points for the wells, their depths, and confirmation of the vertical interval into which the wells have been completed[21] before DOGGR and US EPA can act on its request.

4

Yet, despite the proximity of at least 105 drinking water wells within one mile of the Project, the uncertainty of the ability of potential barriers to contain oil field water, and the fact that dozens of water wells have been built in the Edna Member, and despite repeated requests from the Center and AGOF's neighbors for FMOG to present *detailed* analyses of nearby water wells, FMOG has not provided this information. FMOG's lack of cooperation and data

---

[16] Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, pp. 2-4 (discussing 24 water wells within a one-mile radius that are completed in the Edna Member, and noting that "[t]he Statement of Basis makes an even greater omissions by failing to state that four drinking water wells in Section 32 and seven wells in Section 5, the areas that contain wells nearest to the exemption area, are completed in the Edna Member of the Pismo Formation, the same geologic member and formation that is the subject of the Application.") There are likely more wells completed in this shallow formation, but FMOG has found well completion data for only about half of the 105 wells within one mile of the oil field. (*Id.* at 2.)

[17] Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, p. 3 (map), *see also* Attachment B – cross section showing water well location in proximity to aquifer exemption boundary prepared by registered Professional Geologist Rob Hesse.

[18] Statement of Basis, p. 3.

[19] *Id.* at 4. *See also* NRDC Comments, p. 10, referring to the unit as the "Edna/Dollie Sands Member of the Pismo Formation."

[20] Hagemann, Dec. 14, 2015 Aquifer Exemption Comments, pp. 2-3.

[21] *Id.* at 3.

production is particularly egregious in light of the fact that both DOGGR and the Regional Board *themselves* have required this information, but for some reason have not enforced their requests. As recently as June 2015, DOGGR wrote to FMOG asking for more information to support an exemption:

> Freeport-McMoRan has indicated that some water from the upper Pismo formation is currently being used, which strongly indicates that water from the Pismo has current beneficial use. Freeport-McMoRan needs to confirm that accuracy of the statement that there are no beneficial uses of water, as well as identify all wells and their uses within a one-mile radius of the proposed aquifer exemption.[22]

Meanwhile, in May 2015, the Regional Board issued an order pursuant to California Water Code section 13267 requiring FMOG to submit "technical reports containing information about . . . nearby water supply wells, including domestic wells within a one-mile radius of the injection wells."[23] This information was to include a "list and location map of all water supply wells, including domestic wells, within one mile of each injection well subject to this Order," and:

5

> Information for each identified water supply well, including the well owner name and contact information; type of well (i.e., domestic, irrigation, industrial, etc.); whether any of the water is used for domestic purposes; status (i.e., active, idle, etc.); well construction, including screened interval depths; borehole geophysical logs; and all analytical results for any water sample(s) collected from each water supply well.[24]

A review of Geotracker as of December 15, 2015 shows that FMOG has not submitted this required information,[25] and this information does not appear anywhere in the documentation provided on DOGGR's website to support the exemption.[26] It is important to have this information prior to making a decision on the exemption, in part because FMOG uses solvents and acids to clean and maintain injections wells that must not be allowed to contaminate drinking water.[27]

---

[22] DOGGR, June 8, 2015 Letter, p. 3.
[23] 13267 Order, p. 3, para. f.
[24] *Id.* at 3.
[25] Documents submitted by FMOG in response to the 13267 Order can be found on Geotracker, *available at* http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000006979.
[26] http://www.conservation.ca.gov/dog/Pages/Aquifer_Exemptions.aspx.
[27] Arroyo Grande Oil Field, Injection Project Review (Oct. 22, 2014), Orcutt, CA (power point presentation), p. 18.

In addition to the water well data already required by the Regional Board, the studies and data FMOG must conduct and provide to demonstrate the safety of an exemption are not particularly exceptional or rare, and there is no reason the agencies should not require them in order to protect Californians. For example, as the Natural Resources Defense Council ("NRDC") stated in its September 21, 2015 Aquifer Exemption Comments, "[i]nformation must be collected that demonstrates water level data, relevant geologic features, and discharge rates for steady-state and non-steady state aquifer responses; to ultimately identify any potential *current* communication to the aquifer exemption boundary through a radius of influence induced by a discharge promoted cone of depression."[28] In the attached comments by certified hydrogeologist Matt Hagemann, Mr. Hagemann similarly asserts that FMOG must submit aquifer tests and numerical groundwater models and simulations to evaluate if the oil field is isolated from groundwater used for drinking water.[29] Mr. Hagemann notes that "[n]umerical (computer-based) models of groundwater systems are commonly used to simulate the flow of groundwater, including the response of water levels across aquifer boundaries under conditions of injection and pumping. Aquifer tests, where water is removed or added and where response in adjacent wells is measured, are also critical to test the concept of hydraulic barriers."[30] NRDC further points to the value of providing "permeability or porosity maps or cross-sections documenting the alleged loss in permeability it claims will provide confinement on the east and west sides of the field."[31]

5

Thus, there are available tests and models that can effectively determine or demonstrate FMOG's assertions of aquifer isolation. It is unclear why, then, the agencies are content to rely on guesstimates and inferences rather than require FMOG to submit fundamental information necessary to ensure the safety of those who live near the oil field and of California's scarce water resources.

DOGGR and US EPA Cannot Use Antiquated Criteria to Legitimize Illegal Injection

[28] NRDC Comments, p. 8.
[29] Hagemann, December 14, 2015 Aquifer Exemption Comments, p. 5.
[30] *Ibid.*
[31] NRDC Comments, p. 16.

Even if the documentation did support an exemption under the federal criteria[32] (which it does not), the criteria itself is antiquated, and cannot be the only criteria used to determine whether to allow FMOG to use California's aquifers to inject oil field waste water and steam. The historic drought has fundamentally changed the way Californians use water. It has prompted mandatory water restrictions, new wells that are deeper and that tap into previously unused aquifers, and the serious consideration of alternative water purification technologies. As other comments noted earlier, these regulations are more than thirty years old, and water treatment technology has improved drastically since then, especially as water demand from previously unused groundwater sources has increased due to the drought.[33] For instance, just this week, the Carlsbad desalination plant went online.[34] Even at the time they were adopted, the aquifer exemption criteria were an accommodation to the oil industry rather than regulations based on or rooted in science and technology.[35] DOGGR and US EPA must instead apply 21st-century standards and to 21st-century needs when analyzing whether it is truly appropriate to exempt this aquifer from the protections of the Safe Drinking Water Act.

6

The Center further objects to using this antiquated criteria to legitimize illegal injection into protected aquifers at the AGOF. There are at least eight wells operating at the AGOF permitted to inject into groundwater that is currently protected under the SDWA.[36] DOGGR has passed "emergency" regulations that purportedly allow injection wells such as those at the AGOF to continue to operate until February 2017, by which time they must either receive an exemption or cease operation.[37] DOGGR's own failure to oversee its underground injection

[32] 40 C.F.R. §§ 145.4(a)-(c).
[33] NRDC Comments, p. 1; John Noel, *Aquifer Exemptions: A First-Ever Look at the Regulatory Program That Writes off Drinking Water Resources for Oil, Gas, and Uranium Profits* (Clean Water Action/Clean Water Fund, Jan. 2015) ("Noel"), p. 6, *available at* http://www.cleanwateraction.org/files/publications/Aquifer%20Exemptions%20-%20Clean%20Water%20report%201.6.15.pdf
[34] *See, e.g.,* Bradley J. Fikes, "$1-Billion Desalinaton Plant, Hailed as Model for State, Opens in Carlsbad," *Los Angeles Times* (Dec. 14, 2015), *available at:* http://www.latimes.com/local/california/la-me-desalination-20151215-story.html.
[35] NRDC Comments, p. 1; Noel, p. 6.
[36] Steve Bohlen, State Oil & Gas Supervisor, DOGGR and Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board, Letter to Michael Montgomery, US EPA, Region IX (October 15, 2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/UIC%20Files/20151015%20-%20Joint%20Letter%20to%20US%20EPA%20Cat%201%20Well%20Review%20Findings.pdf.
[37] Cal. Code Regs. tit. 14 § 1779.1(a).

program and prevent illegal injection[38] does not constitute an "emergency" in need of continued unlawful activity, however. An "emergency" is a situation that calls for immediate action to "avoid serious harm to the public peace, health, safety, or general welfare."[39] In contrast, here, DOGGR's "emergency" regulations increase, rather than stem, a public emergency by perpetuating ongoing contamination that threatens public health and general welfare. In fact, the SDWA expressly prohibits a state agency's promulgation of regulations that relieve it or other parties from the Act's requirements, stating, "no law or regulation" adopted or enforced by a state agency "shall relieve any person of any requirement otherwise applicable under" the SDWA.[40] DOGGR's attempt to "codify" illegal activity is wrong, and the US EPA must not reward DOGGR and FMOG for illegally injecting over 63 million gallons of waste water and steam into a protected aquifer[41] by suddenly sanctioning it pursuant to outdated criteria.

7

Even if US EPA intends to follow the "emergency" regulations, illegal injection at the AGOF must cease. As the US EPA itself noted, the aquifer is both below 3,000 TDS and is not entirely hydrocarbon producing.[42] Therefore, the earliest deadline set out in the regulations for illegal injection to cease must apply here: "If the portion of the aquifer is injection is approved is not a hydrocarbon producing zone and the groundwater has less than 3,000 TDS, then injection shall cease by October 15, 2015," rather than February 15, 2017.[43] As October 15, 2015 has passed, all illegal injection must stop immediately.

Finally, what is perhaps most disturbing about DOGGR's actions in remedying its failure to effectively administer the underground injection ("UIC") program is that during the time when DOGGR has supposedly been reviewing the *thousands* of wells it permitted to inject into protected aquifers and committing itself to more stringent injection regulation, DOGGR has been *continuing to issue permits for injection wells in nonexempt areas of the aquifer at the AGOF*. On November 16, 2012, DOGGR acknowledged that it had been aware since 2009 that its UIC program had failed to comply with state law and regulations, including failing to protect aquifers to the extent required by the US EPA.[44] It committed to fixing the program and reviewing the non-compliant wells. In the

[38] For a description of this failure, *see e.g.,* CBD, Sept. 21 Aquifer Exemption Comments, pp. 2-3; CBD, Oct. 21, 2015 CUP Phase IV Extension Comments, pp. 6-7.
[39] Cal. Gov. Code § 11342.545.
[40] 42 U.S.C. § 300h-2(d). *See also* 42 U.S.C. § 300f (defining "person" to include state agencies).
[41] *See* NRDC Comments, p. 6, Table 2.
[42] DOGGR, June 8, 2015 Letter, p. 3.
[43] Cal. Code Regs. tit. 14 § 1779.1(a)(1).
[44] Letter from Tim Kustic, State Oil and Gas Supervisor, DOGGR to David Albright, Manager, Ground Water Office US EPA Region IX, Response to the US EPA June 2011 Review of California's UIC

meantime, DOGGR issued permits to drill or rework injection wells in the non-exempt portion of the AGOF aquifer.[45] The permits to rework the injection wells contained no condition making injection contingent on receipt of an aquifer exemption. There is simply no basis for DOGGR to continue on this path of allowing such injection to continue, or for the US EPA to condone DOGGR's actions in failing to protect California's precious groundwater by approving this exemption.

7

The AGOF is Exceedingly Energy and Water Intensive; the Exemption and Planned Expansion Will Frustrate the State's Climate and Water Goals

According to data collected by the California Air Resources Board ("CARB") for implementation of the Low Carbon Fuel Standard ("LCFS") in 2014, the water to oil ratio at the AGOF was 17.58.[46] This ratio is already higher than the state oil field average, which is 15.[47] According to FMOG's data in its aquifer exemption application,[48] current production from 221 active production wells is 29,750 bpd of water and 1,350 bpd of oil,[49] which provides a water to oil ratio of 22. Despite the addition of new injection wells and production wells, the efficiency of oil production at AGOF appears to be decreasing, requiring larger volumes of water to produce smaller amounts of oil. The decreasing efficiency of production means that the oil field's energy intensity and water usage is going to increase, as it takes ever larger amounts of steam to produce oil.

8

Program (Nov. 16, 2012) ("November 16, 2012 letter") and Attachment to November 16, 2012 letter: Response to the US EPA June 2011 Review of California's UIC Program, p. 1. *See also* Letter from David Albright, Manager, Ground Water Office, US EPA Region IX, to Elena Miller, State Oil and Gas Supervisor, DOGGR (July 18, 2011) ("July 18, 2011 letter").

[45] *See, e.g.,* Document titled "02806003 #2 of 2, pdf" (produced by DOGGR on Dec. 8, 2015, in response to a Public Records Request from the Center for Biological Diversity dated Nov. 2, 2015), pp. 19-24 (permits to drill injection wells, conditioned on receipt of an aquifer exemption, in 2014); pdf pp. 52, 53, 55, 60, 62 (permits to rework injection wells in non-exempt aquifer, not conditioned on receiving exemption, in 2013-2014).

[46] LCFS Crude Oil Lifecycle Assessment, California Air Resources Board, *available at* http://www.arb.ca.gov/fuels/lcfs/crude-oil/crude-oil.htm (OPGEE 1.1E).

[47] *Ibid.*

[48] Arroyo Grande Oilfield Edna Member Dollie Sands Pismo Formation Aquifer Exemption Application, DOGGR, ("FMOG, Aquifer Exemption Application"), *available at* ftp://ftp.consrv.ca.gov/pub/oil/Aquifer_Exemptions/County/San_Luis_Obispo/Arroyo_Grande_Oilfield/Dollie_Sands_Pismo_Formation/Arroyo%20Grande%20Oilfield%20Edna%20Member%20Dollie%20Sands%20Pismo%20Formation%20Aquifer%20Exemption%20Application%20Complete.pdf.

[49] *Id.* at 17.

This is of concern not only because of the water and energy intensity of the field in the context of California's severe drought, but also in the context of California's climate laws, including the LCFS and AB 32. Producing oil at the AGOF is extremely carbon intensive, with a carbon intensity ("CI") value (which includes producing and transporting the oil to be refined) of 27.81 compared to a state average of approximately 7.[50] It is one of the top ten most carbon-intensive fields in the state, with a higher CI value than dirty Canadian tar sands and far in excess of the CI of any imported oil to California, even taking into account the energy required in the transportation of oil from distant countries.[51] At the same time, the oil produced at AGOF has a low API (high specific gravity) of 14,[52] which means that it is an extra heavy oil, thus energy intensive to refine as well as to produce.

8

While the AGOF requires ever more steam and energy to produce less and less oil per well, FMOG intends to continue to expand and simultaneously dewater the oil field. This raises concerns about where the produced water will end up and the composition of that water, which are not addressed in the documentation supporting the aquifer exemption application. The Water Reclamation Facility ("WRF") at AGOF, for instance, was built to handle a throughput of only 20,000 bpd of water.[53] The AGOF, however, currently produces 29,750 bpd of water[54]—meaning that over 9,000 bpd of water per day must be disposed of without treatment at the WRF. This produced water contains high levels of chemicals and metals, including VOCs such as benzene, chromium, lead, and aluminum, among many others.[55] At the same time, according to FMOG's aquifer exemption documentation, the oil field currently discharges 18,050 barrels per day (bpd) of treated water into Pismo Creek, an amount equal to 64 percent of the water

---

[50] Calculation of 2014 Crude Average CI Value, California Air Resources Board (June 16, 2015), *available at* http://www.arb.ca.gov/fuels/lcfs/crude-oil/2014_crude_average_ci_value_final.pdf.
[51] *Ibid.*
[52] Crude Oil Lifecycle Assessment, California Air Resources Board, *available at* http://www.arb.ca.gov/fuels/lcfs/crude-oil/crude-oil.htm (OPGEE 1.1E). According to this data, the state average is approximately 25.
[53] PXP Produced Water Reclamation Facility Subsequent Environmental Impact Report (2008), ch. 3, "Project Description," *available at* http://www.slocounty.ca.gov/Assets/PL/environmental/plains/Historical+Documents/2008+-+RO+Water+System+EIR/EIR+Documents/06+Chapter+3.0+Project+Description.pdf.
[54] FMOG, Aquifer Exemption Application, p. 17.
[55] FMOG, Response to CCRWQCB 13267 Order (August 21, 2015), Attachments A, 1-4 (Analyses of Groundwater from Each Injection Zone), *available at* http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000006979.

produced by AGOF.[56] A NPDES discharge permit issued by the Regional Board for this facility, effective from February 1, 2014 through February 1, 2019, allows a maximum discharge of 0.84 million gallons per day (MGD) into Pismo Creek.[57] The current discharge, converted to gallons, is 0.758 MGD. For FMOG to comply with this water board permit, it can only discharge an additional 0.082 MGD into Pismo Creek. If FMOG expands operations at AGOF, it will produce more water. The expansion would require FMOG to find alternate means of disposing of produced water, either through additional injection, taking water offsite, a sump, or some other means. Presumably, the excess water that cannot go through the WRF or into Pismo Creek will be reinjected into the area of the aquifer that is currently the subject of this exemption application, but FMOG has not provided the exact details of this plan, such as the volume or composition of water that will be injected.

8

Conclusion

Even if DOGGR and US EPA apply the antiquated federal exemption criteria to this aquifer, it fails to meet state and federal requirements for exemption from the SDWA. FMOG has not shown that the aquifer is not now or could not in the future be used for drinking water or that it will not affect other beneficial use water. DOGGR and the US EPA cannot approve this exemption request, and all injection into the non-exempt aquifer must cease immediately. Furthermore, not only has the science and technology changed since the federal aquifer exemption regulations were put in place over thirty years ago, but also the regulatory environment has changed significantly. Since the 1980s, California has seen the passage and implementation of AB 32, the LCFS, and water restrictions due to a historic and severe drought. As a result of these and other changes in environmental law, science, and technology since the 1980s, the exemption criteria are no longer enough. The agencies must consider these advances of the last thirty years in determining whether to issue this exemption. In doing so and in order to protect Californians, the agencies must reject the aquifer exemption.

---

[56] FMOG, Aquifer Exemption Application, p. 17. The 18,050 bpd discharged to Pismo Creek is 64 percent of AGOF's reported 29,750 bpd of produced water. *Ibid. See also* Hagemann Attachment, p. 6, to CBD, Nov. 25, 2015 Appeal.

[57] Central Coast Regional Water Quality Control Board, Draft Order R3-2013-0029, NPDES No. CA0050628 (December 5, 2013), pp. 4, 56-59, 64, 81, and 87.

Sincerely,

Maya Golden-Krasner
Climate Staff Attorney

LIST OF REFERENCES CITED AND ATTACHED

Center for Biological Diversity, Appeal from Planning Commission Decision on November 12, 2015 yo San Luis Obispo County Supervisors File Number DRC20150002 (November 25, 2015) and attached letter from Matt Hagemann

Abel, Patricia, District Deputy, DOGGR, letter to Kenneth R. Bork, Agent, Freeport-McMoRan Oil & Gas, LLC Re: Arroyo Grande Oil Field, Aquifer Exemption, Dollie Zone of Pismo Fm (June 8, 2015)

Albright, David, Manager, Ground Water Office, US EPA Region IX, letter to Elena Miller, State Oil and Gas Supervisor, DOGGR (July 18, 2011)

Bohlen, Steve, State Oil & Gas Supervisor, DOGGR and Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board, Letter to Michael Montgomery, US EPA, Region IX (October 15, 2015)

Center for Biological Diversity, Comments on the Arroyo Grande Oil Field Aquifer Exemption Application (September 21, 2015)

Center for Biological Diversity, Comments to San Luis Obispo Planning Commission re: Freeport-McMoRan Oil & Gas, LLC, Arroyo Grande Oil Field, Application to Extend Phase IV CUP # D010386D (October 21, 2015)

Center for Biological Diversity, Comments to San Luis Obispo Planning Commission re: Freeport-McMoRan Oil & Gas, LLC, Arroyo Grande Oil Field, Application to Extend Phase IV CUP # D010386D--Supplemental Information (Nov. 11, 2015) and attached letter from Matt Hagemann

Central Coast Regional Water Quality Control Board, Order Pursuant to California Water Code section 13267 (May 14, 2015)

Central Coast Regional Water Quality Control Board, Draft Order R3-2013-0029, NPDES No. CA0050628 (December 5, 2013)

Department of Conservation (DOGGR),"02806003 #2 of 2, pdf" (produced by DOGGR on Dec. 8, 2015, in response to a Public Records Request from the Center for Biological Diversity dated Nov. 2, 2015)

DOGGR Response to the US EPA June 2011 Review of California's UIC Program

Freeport MacMoRan Oil and Gas, Arroyo Grande Oil Field, Injection Project Review (Oct. 22, 2014), Orcutt, CA (power point presentation)

Hagemann, Matt, PG, C. Hg., Comments on the Arroyo Grande Aquifer Exemption Application (December 14, 2015)

Kustic, Tim, State Oil and Gas Supervisor, DOGGR letter to David Albright, Manager, Ground Water Office US EPA Region IX, Response to the US EPA June 2011 Review of California's UIC Program (Nov. 16, 2012)

Natural Resources Defense Council, Aquifer Exemption Comments (Sept. 21, 2015)

Attachment A

Center for Biological Diversity comments on
Arroyo Grande Oil Field
Supplement to Aquifer Exemption Application

SWAPE Technical Consultation, Data Analysis and Litigation Support for the Environment

2656 29th Street, Suite 201
Santa Monica, CA 90405

Matt Hagemann, P.G, C.Hg.
(949) 887-9013
mhagemann@swape.com

December 14, 2015

Maya Golden-Krasner
Center for Biological Diversity
1212 Broadway, Suite 800
Oakland, CA 94612

Subject: Comments on the Arroyo Grande Aquifer Exemption Application

Dear Ms. Golden-Krasner:

I have reviewed the December 2, 2015 Arroyo Grande Aquifer Statement of Basis prepared by the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) and the State Water Resources Control Board and the Central Coast Regional Water Quality Control Board. I have also reviewed the 2015 Arroyo Grande Oilfield Aquifer Exemption Application prepared by the applicant, Freeport-McMoRan. The impacts to groundwater and drinking water resources have been the focus of my reviews of these materials.

I am licensed as a Professional Geologist and a Certified Hydrogeologist in California. My professional career spans over 25 years, including nine years with U.S. EPA Region 9. At the U.S. EPA, I was a geologist in the Groundwater Protection Section which included the regional branch of the Underground Injection Control Program. I also was responsible for the designation of two Sole Source Aquifers under provisions of the Safe Drinking Water Act and implementation of the Wellhead Protection Program. At the U.S. EPA I also held the position of Senior Science Policy Advisor. I am a partner in the consulting firm I helped to found 12 years ago.

Impacts from oil company operations on water resources has been the subject of recent public scrutiny. The California program which allows injection of produced water and well stimulation fluids into aquifers that are sources of drinking water has "serious deficiencies" according to the U.S. EPA.[1] The U.S. EPA is the process of determining if DOGGR's program meets regulatory requirements for the Class II Oil and Gas Underground Injection Program. An underlying foundation to the Class II Program is that injection of oilfield wastewater into aquifers is not allowed unless the groundwater has been exempted as a source of underground drinking water. Some of the injection of fluids into the Arroyo Grande oil field has been occurring into a non-exempt aquifer, necessitating Freeport-McMoRan to apply to expand

[1] ftp://ftp.consrv.ca.gov/pub/oil/UIC%20Files/CA%20Class%20II%20UIC%20letter%20December%2022%202014.docx.pdf , p. 3

its existing aquifer exemption for the Dollie Sands, a stratigraphic unit within the Edna Member of the Pismo Formation.

For DOGGR, the Water Board, and the public to adequately evaluate the Application, fundamental information is needed, including accurate information on where drinking water wells are located and how they will respond to the withdrawal and injection of fluids in the area of exemption. The need for accurate information on the drinking water wells is critical because of their immediate proximity to the exemption area and their completion within the same vertical geologic interval.

Drinking Water Wells Immediately Adjacent to the Area Proposed for Exemption Need to be Identified and Accurately Mapped

9

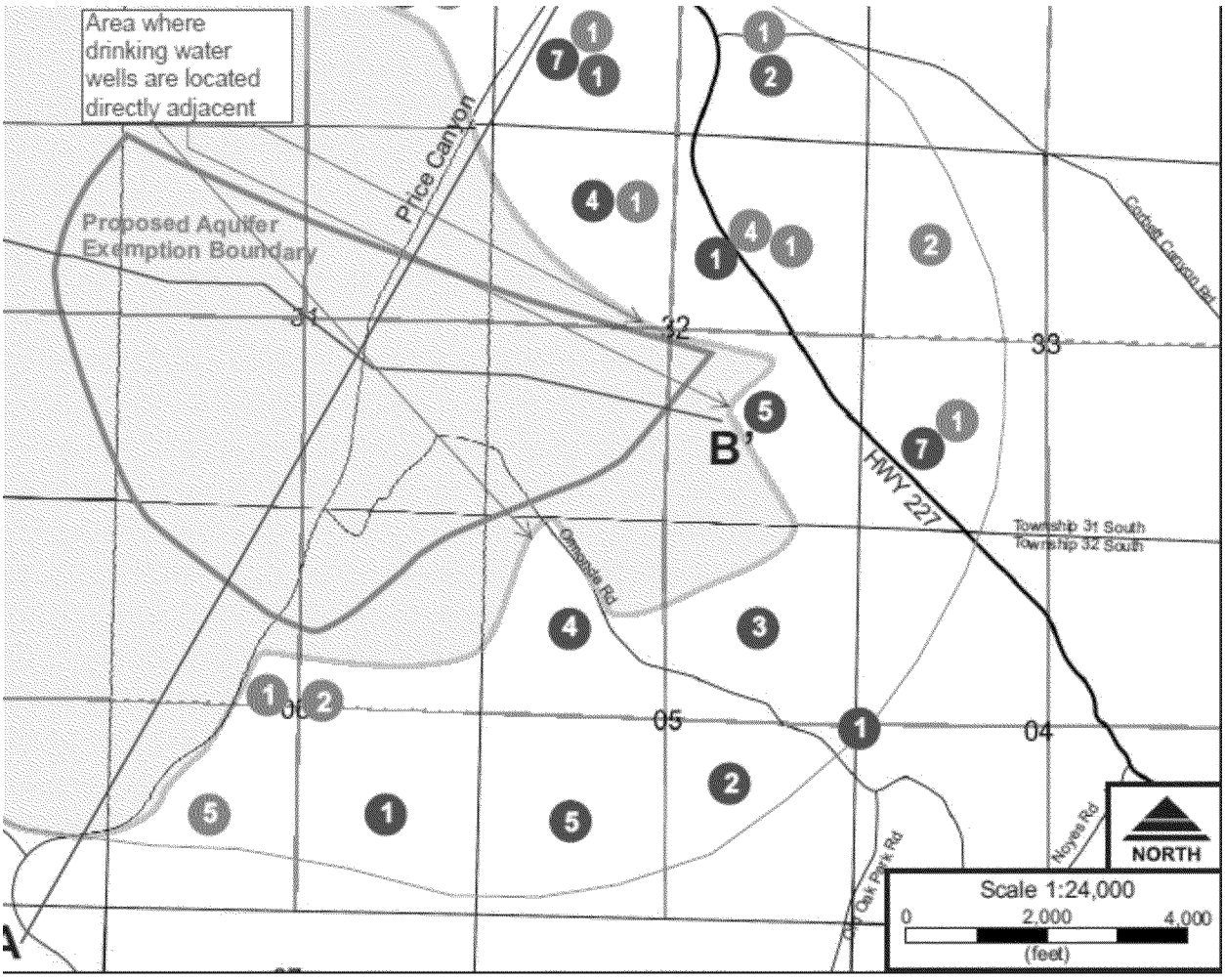
Information included in the Application shows at least 105 drinking water wells to be located within a one-mile radius of the area that has been proposed for exemption.[2] Of these drinking water wells, 24 are known to have been completed in the Edna Member of the Pismo Formation, the same geologic formation and member that is proposed for exemption. (This is a minimum number because well completion data has only been obtained for about half the 105 wells known to be within a one-mile radius of the Project.) The Statement of Basis states "none of the nearby water supply wells are pumping water from the Dollie Sands member of the Pismo Formation" (p. 3) but fails to state that the Dollie Sands are part of the Edna Member of the Pismo Formation, the source of drinking water for the 24 wells adjacent to the exemption area. According to information included in the Application, some wells in the Edna Member produce drinking water from depths up to 510 feet.[3] Injection into the Edna Member in the exemption area occurs at depths as shallow as 600 feet (p. 17).

No map has been prepared for inclusion in the public record for the exemption process or for the Project to accurately show where the 105 drinking water wells are located in an aerial sense. The only maps that have been prepared show well locations in a very general sense. The map, included in the Statement of Basis as Figure 1, and as included below, depicts the 105 drinking water wells on a scale that does not allow for accurate location and uses only dots that are gradational in scale to schematically identify the location of the 105 wells that lie within the one-mile radius of the Project.

Features on the map indicate the immediate proximity of drinking water resources with the proposed aquifer exemption area. The map delineates an "Area with no known water supply wells" that touches upon the northeast corner of the "Proposed aquifer exemption boundary." The juxtaposition of these two boundaries indicates no aerial buffer between the exemption area and the adjacent drinking water. An area on the eastern edge of the "Area with no known water supply wells" (near the B' endpoint of the B-B' cross section and along Ormonde Road) indicates a buffer of just 500 to 1000 feet between the exemption area and the adjacent drinking water.

[2] Review of DWR Well Completion Reports Within One-Mile of the Freeport McMoRan Arroyo Grande Oil Field, June 25, 2015, Cleath-Harris Geologists, Inc., Table A2

[3] Ibid.



Note: Green dots represent wells completed in Pismo Formation aquifers (to include the Edna Member)

The map shows drinking water wells in the Pismo Formation to be approximately located less than two football fields from the exemption area. The Application and the Statement of Basis should identify and disclose the distance of all drinking water wells within a one-mile radius to the exemption area and should confirm the vertical interval (i.e. Geologic Formation and Member) in which the wells are completed. 9

The Application and Statement of Basis should also evaluate the ability for proposed sentry wells to adequately serve as a warning system for potential contamination. Because of the proximity of the drinking water wells to the exemption area, a detection of contamination in the sentry wells would likely be too late to serve as adequate warning to shut down drinking water wells.

Hydraulic Intercommunication with Exemption area and Drinking Water Wells Needs Evaluation

The exemption application and Statement of Basis claim that the drinking water aquifer and wells are laterally isolated from oil field activities by a fault to the north, the discontinuity of the Edna Member to the south, and a tar seal and loss of permeability to the east and west. The claim that the exemption area is hydraulically isolated from drinking water wells is supported by highly interpretive data. The 10

application and the Statement of Basis summarize a conceptual model to support this idea but it is a model that has not been evaluated through aquifer tests or through use of numeric groundwater models. Further evaluation of the lateral boundaries is imperative because drinking water wells are located directly adjacent to the exemption area.

The Application and the Statement of Basis attempt to explain that the four sides of the proposed exemption area act as hydraulic barriers or are hydraulically isolated, impeding intercommunication between drinking water. None of the boundary conditions cited by the Applicant are known to create an impermeable hydraulic barrier that would preclude the intercommunication of drinking water aquifers with oil field activities, which include injection and extraction.

1. The Statement of Basis states that there is a facies change to the east of the proposed exempted area and states the Miguelito Member forms the base of a synclinal bowl that represents a low permeability "layer of protection for adjacent drinking water wells." What the Statement of Basis fails to mention is that 24 drinking water wells within the one-mile radius are completed in the Edna Member, and only 6 are completed in the Miguelito Member.[4] The Statement of Basis makes an even greater omission by failing to state that four drinking water wells in Section 32 and seven wells in Section 5, the areas that contain wells nearest to the exemption area, are completed in the Edna Member of the Pismo Formation, the same geologic member and formation that is the subject of the Application.[5] Therefore, the Miguelito Member which underlies the Edna Member, cannot serve as a barrier to hydraulic intercommunication between wells in the exemption area and drinking water wells completed in the Edna Member.

10

2. The fault that forms the northern boundary of the proposed exemption area is also cited in the Statement of Basis as a barrier to "restrict" (p. 4) flow to/from adjacent drinking water. No tests, including pump tests or aquifer tests, have been performed to validate this idea and how much hydraulic "restriction" is represented by the fault barrier in the area adjacent to drinking water wells. Given that drinking water wells exit in the Edna Member directly across the fault from the proposed exemption area, the idea that the fault "restricts" water flow should be evaluated using an aquifer test where water is added or withdrawn within the exemption area and the hydraulic response in adjacent drinking water wells is measured. Another important line of evaluation would be the use of a numerical groundwater model to simulate conditions of pumping and withdrawal in the exemption area and the hydraulic response in adjacent water wells.

3. Inward hydraulic gradients are also touted as protecting adjacent drinking water, preventing overflow of water in the bowl to adjacent groundwater. However, the inward gradient may induce flow of groundwater across the fault boundary and across any hydraulic boundary that is represented by the tar sands. Any boundary condition cited by the applicant as an impermeable hydraulic seal isolating the oil field with the adjacent drinking water aquifers, must be evaluated in light of the amount of water that is removed from the oil field, a condition known as dewatering. Since approval of the Project, aquifer dewatering has been actively pursued by the

[4] Review of DWR Well Completion Reports Within One-Mile of the Freeport McMoRan Arroyo Grande Oil Field, June 25, 2015, Cleath-Harris Geologists, Inc., Table A2

[5] Ibid.

applicant. Over the past two years, net water extraction from the aquifer has averaged of 18,050 barrels, or 2.33 acre-feet/day. The dewatering lowers hydraulic pressure and creates a "sink," according to the applicant. The impact of this pressure sink on inducing flow from adjacent drinking water resources and across the exemption boundaries has not been evaluated and should be tested using aquifer tests and a numeric model.

4. The tar seal is identified on the east and west sides of the proposed exempted area "to act as a fluid barrier and restrict groundwater flow across these boundaries" (Statement of Basis, p. 4). This statement admits that groundwater flow is restricted but not contained across the tar sands. Since flow is not hydraulically contained, the aquifer that serves as the source of drinking water for adjacent wells is hydraulically connected to the exemption area.

   The very presence of the tar seal is also in doubt. A geologic cross section prepared by the Applicant shows the boundary of the tar seal to be represented by a dashed line (Aquifer Exemption Application, Appendix A 7 a 2, Cross Section B to B'). The use of a dashed line in these cross section means that the existence of the tar seal is uncertain, according to geologic mapping conventions. Therefore, the ability of the tar seal to form a lateral boundary separating Project wells from drinking water wells is unknown

10

The ability of the four boundary conditions cited in the Application and Statement of Basis to contain water in the exempted area from intercommunication with adjacent wells is unknown. Boundary conditions need to be evaluated through use of a numerical groundwater model to estimate response in the aquifer to Project injection and pumping. Numerical (computer-based) models of groundwater systems are commonly used to simulate the flow of groundwater, including the response of water levels across aquifer boundaries under conditions of injection and pumping. Aquifer tests, where water is removed or added and where response in adjacent wells is measured, are also critical to test the concept of hydraulic barriers.

Conclusions

Approval of the Application be withheld until:

1. Fundamental information on drinking water wells, including locations and cross sectional correlations to injection wells and pumping wells, presented;
2. Boundary conditions are defined through aquifer test and numerical simulations to evaluate if the oil field is isolated from groundwater used for drinking water; and
3. The public has an opportunity to review and comment on this essential information.

Sincerely,

M Hagemann

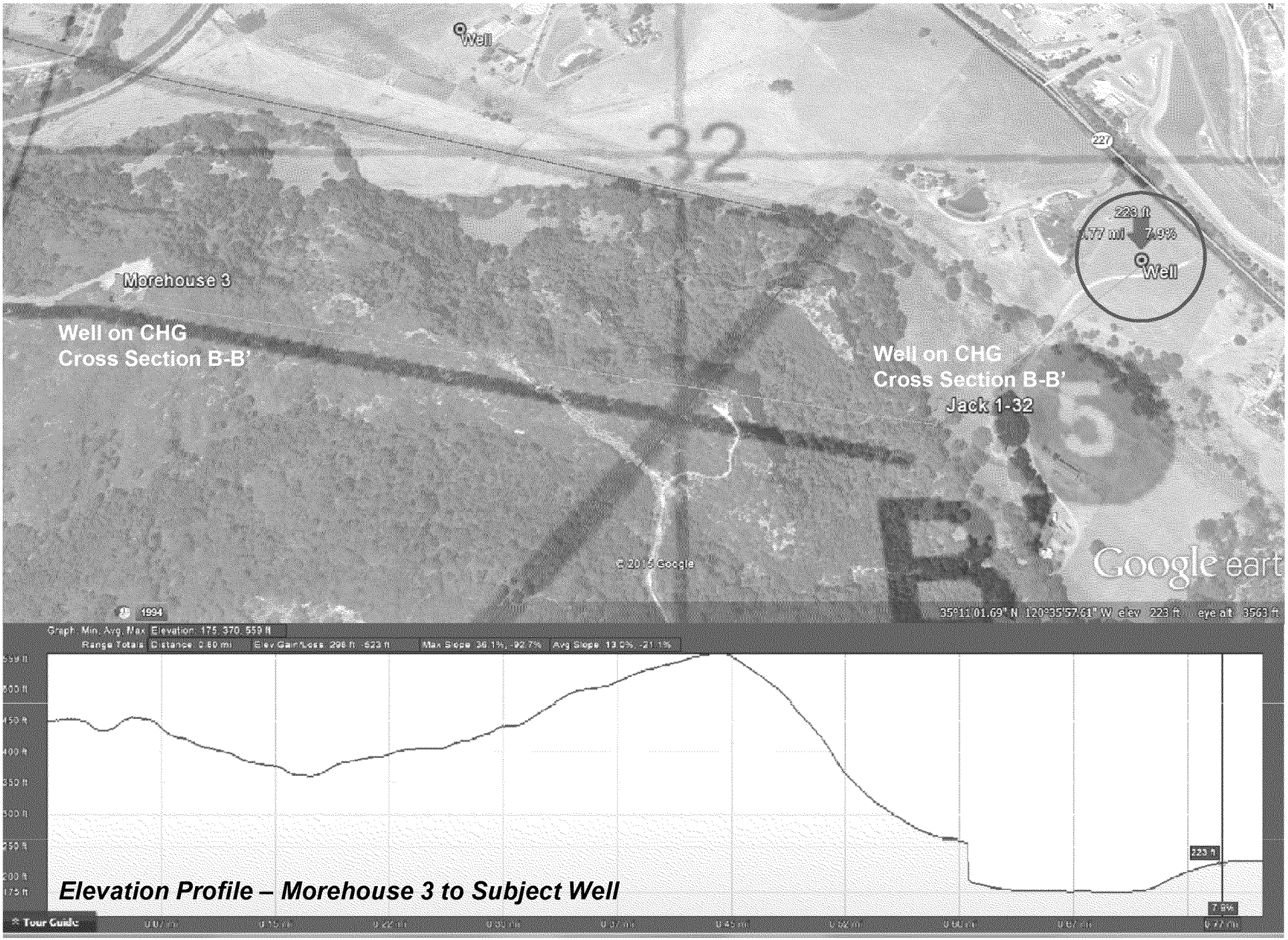
Matt Hagemann, P.G., C.Hg.

Attachment B

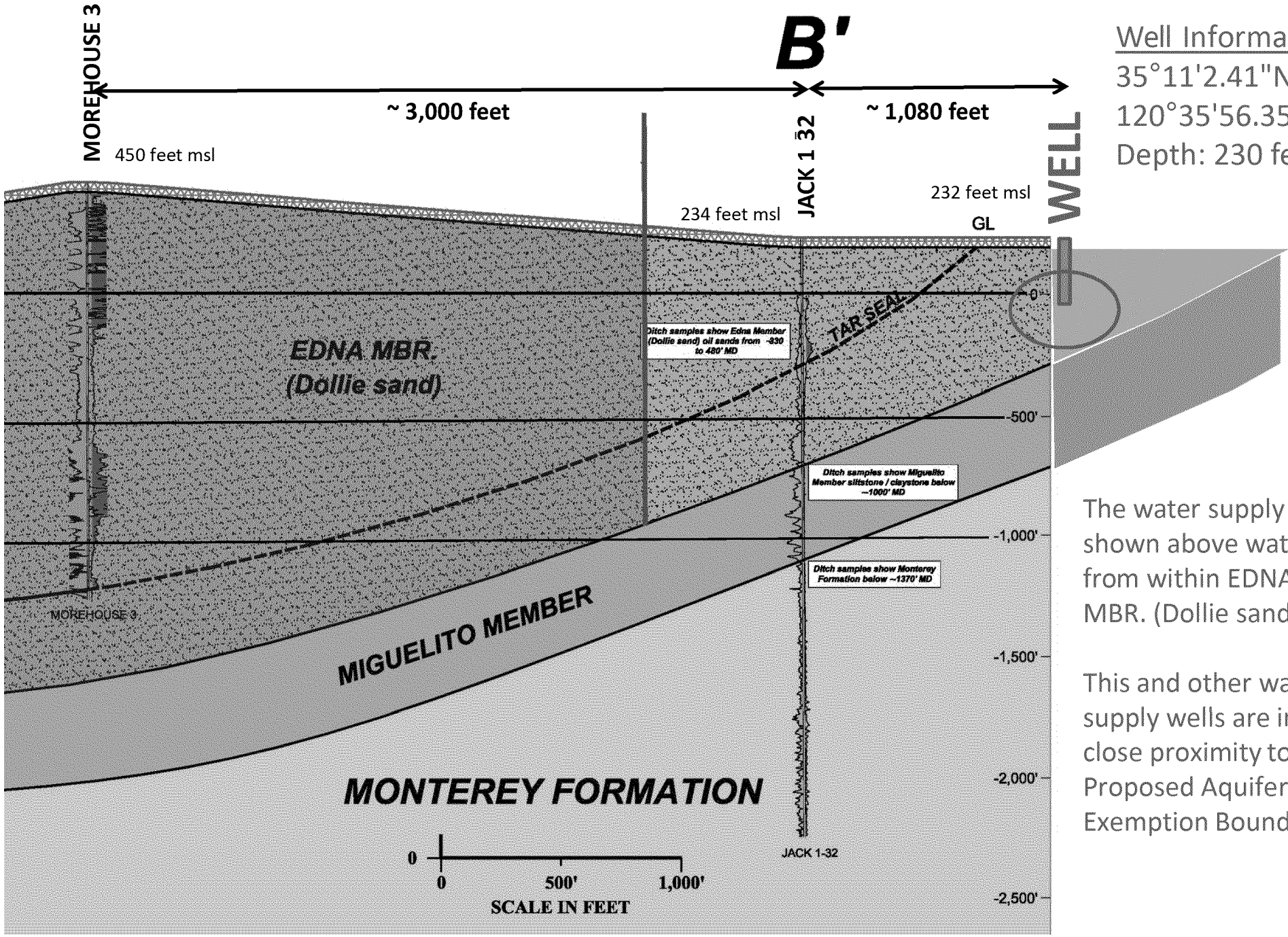
Prepared by Professional Geologist Rob Hesse

Center for Biological Diversity comments on
Arroyo Grande Oil Field
Supplement to Aquifer Exemption Application

Location of Example Water Supply Wells Near Proposed Aquifer Exemption Boundary



Amended Cross Section a Nearby Well to the Proposed Aquifer Exemption Boundary



Well Information
35°11'2.41"N,
120°35'56.35"W
Depth: 230 feet

The water supply well shown above water from within EDNA MBR. (Dollie sand).

This and other water supply wells are in close proximity to the Proposed Aquifer Exemption Boundary.

From: Mordick, Briana
To: Comments@DOC
Subject: ATTN: Aquifer Exemption
Date: Wednesday, December 16, 2015 3:53:27 PM
Attachments: NRDC-CWA-SuppComments_AG-AE_16Dec15_Final.pdf

Dear Supervisor Harris:

Please accept these comments on the supplemental information for the proposal to expand the current aquifer exemption in the Arroyo Grande Oil Field, submitted by the Natural Resources Defense Council and Clean Water Action.

Respectfully submitted,
Briana Mordick

BRIANA MORDICK
Senior Scientist

NATURAL RESOURCES DEFENSE COUNCIL
111 SUTTER ST., 20TH FLOOR
SAN FRANCISCO, CA 94104
T 415.875.8270
BMORDICK@NRDC.ORG
NRDC.ORG

December 16, 2015

Mr. Kenneth Harris
Division of Oil, Gas & Geothermal Resources
Department of Conservation
801 K Street, MS 24-02
Sacramento, CA 95814

ATTN: Aquifer Exemption

Submitted electronically via Comments@conservation.ca.gov

On behalf of the Natural Resources Defense Council ("NRDC"), which has 2.4 million members and activists, more than 380,000 of whom are Californians, and Clean Water Action ("CWA"), which has 1 million members nationwide, 50,000 of whom are Californians, we write to submit our comments on the supplemental information for the proposal to expand the current aquifer exemption designation for the Dollie Sands of the Pismo Formation in the Arroyo Grande Oil Field located in unincorporated San Luis Obispo County, near the intersection of Ormonde Road and Price Canyon Road.

1 The supplemental information has not addressed the serious concerns we raised in our previous comment letters and contains nothing that would lead us to change our previous assessment that both the current exemption and the proposed expansion may endanger Underground Sources of Drinking Water ("USDW"). Neither the original application nor the supplemental information contains a meaningful hydrogeological analysis or the data required to support a defensible groundwater flow model. As we also stated in our previous letters, the proposed aquifer exemption at issue here fails to meet even the U.S Environmental Protection Agency's ("EPA") inadequate and outdated exemption criteria, much less the more stringent "beneficial use" requirements set forth in the California Public Resources Code. We therefore renew our objection to this aquifer exemption expansion, and again ask the Division and the Water Boards to reject this application and refrain from sending it on to EPA for approval.

We also renew our objection to the use of the existing, outdated exemption criteria. These criteria are wholly inadequate to protect usable groundwater, and no additional exemptions should be granted under these dangerous criteria.

Respectfully submitted,

Lance Larson
Science Fellow
Natural Resources Defense Council

Briana Mordick
Senior Scientist
Natural Resources Defense Council

Damon Nagami
Senior Attorney & Director
Southern California Ecosystems Project
Natural Resources Defense Council

George Peridas
Senior Scientist
Natural Resources Defense Council

Andrew Grinberg
Oil and Gas Program Manager
Clean Water Action

Criterion 146.4(a) Has Not Been Met

In order to receive an exemption, the applicant must demonstrate that the proposed aquifer exemption meets the criteria at 40 CFR §146.4(a), which states that an aquifer can only be exempted if "(a) It does not currently serve as a source of drinking water." The applicant has not adequately demonstrated that the proposed aquifer does not currently serve as a source of drinking water.

In attempting to justify criteria 146.4(a) the supplemental information includes a new map displaying the spatial locations of the nearest drinking water wells which are located outside of the aquifer exemption boundary. The nearest wells are located approximately 1,000 feet south of the exemption boundary, while the remaining wells are within roughly one mile from the aquifer exemption boundary. The applicant, DOGGR, and SWRCB still have not provided geospatial information for the nearby water supply wells or well logs and completion reports.

2

It appears that the proposed aquifer exemption boundary was drawn in an effort to avoid current water wells rather than actually performing the analysis necessary to determine whether the proposed injection activities could impact those wells. EPA recommends performance of a capture zone analysis ("CZA") to demonstrate criteria 146.4(a); however, the applicant did not perform such an analysis and the concept is not even discussed in the proposed exemption application.[1] The CZA is a scientific characterization of radius of influence around a given pumping well, which largely depends on the pumping rate and intrinsic structural aquifer characteristics (See figure 1). In other words, groundwater located substantial distances laterally and vertically could be 'currently' used by a private well owner, because the radius of influence is drawing water. As EPA states, "a drinking water well's current source of water is the volume (or portion) of an aquifer which contains water that will be produced by a well in its lifetime."[2] NRDC raised these issues in our previous written comments and this was not addressed or acknowledged.

[1] Grevatt, Peter. (July 24, 2014). *Enhancing Coordination and Communication with States on Review and Approval of Aquifer Exemption Requests Under SDWA.* [Memorandum]. Washington, D.C.: U.S. Environmental Protection Agency, Office of Groundwater and Drinking Water.
[2] *Ibid.*

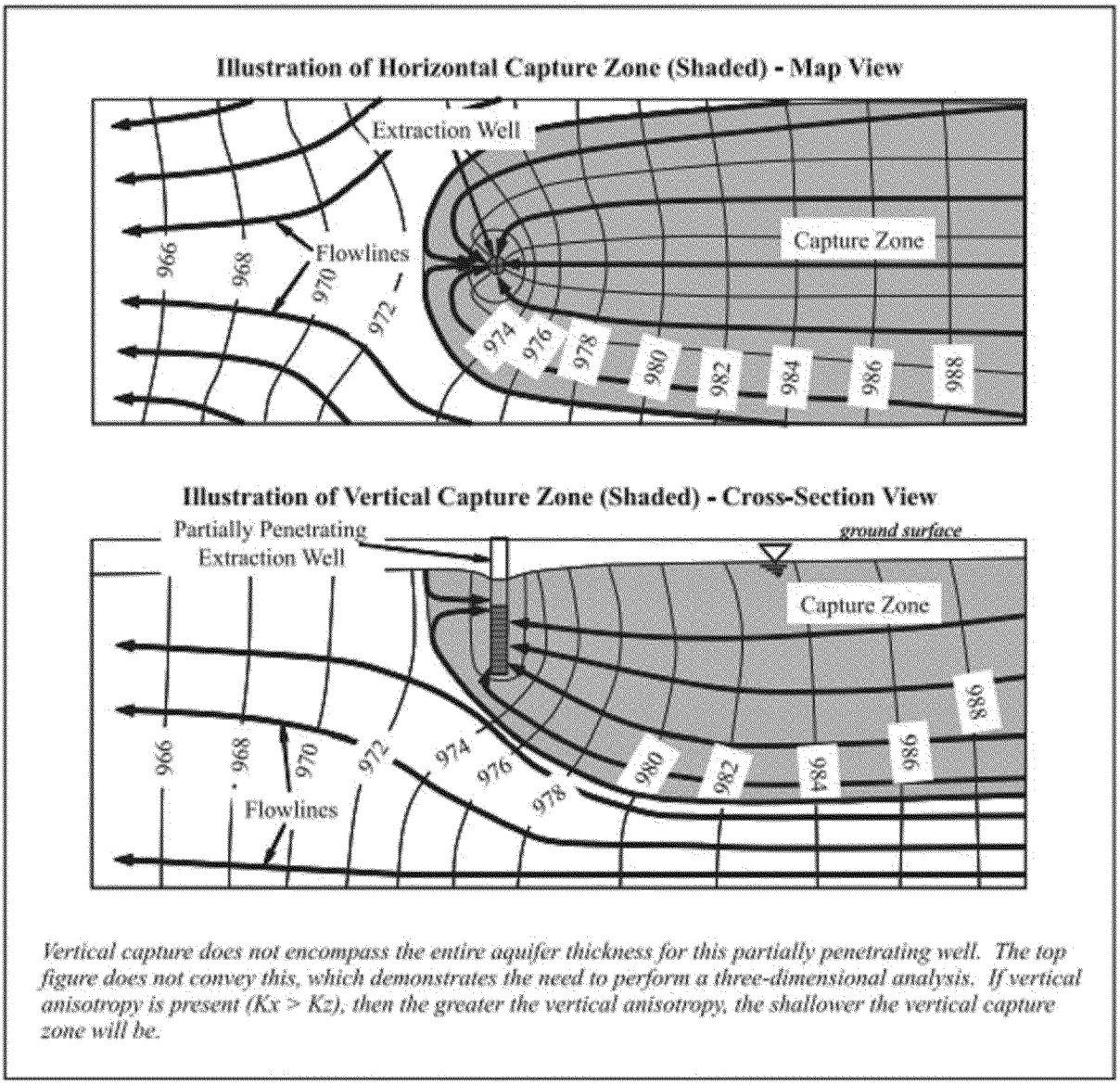


Figure 1: Illustration of horizontal and vertical capture zones. Source: U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Office of Research and Development. (2008). ***A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, FINAL PROJECT REPORT.*** **Washington, D.C.: U.S. Environmental Protection Agency.**

2 In other words, arbitrary land boundaries have absolutely no impact on subsurface flow and groundwater contaminant transport. While the water wells near the proposed aquifer exemption are not *physically* located within the aquifer exemption boundary, the groundwater which those wells withdraw may reside within the aquifer exemption boundary. That would be clarified with CZA analysis; however, a CZA has not been demonstrated and the data required to perform this analysis have not been provided either by the applicant or by the Division of Oil, Gas, and Geothermal Resources ("DOGGR") or the State Water Resources Control Board ("SWRCB").

Clearly, this is an important analysis for demonstrating criteria 146.4(a). As we stated in our initial comments, from a recent aquifer exemption in Texas, EPA denied a portion of a proposed aquifer exemption boundary due to "…significant lack of ground water elevation data for this area."[3] Furthermore, EPA stated "EPA cannot accurately determine whether the area would currently act as a source of drinking water because of the lack of data needed to determine the ground water flow direction north of the Northwest Fault."[4] Therefore, EPA rescinded a portion of the aquifer exemption that did not have sufficient ground water information to show that the aquifer was not currently being used.

2

The anecdotal evidence and numerous vague and/or confusing statements which we noted in our previous comments, indicating that the analysis of existing drinking water wells/uses is incomplete, have not been addressed.

Even with the supplemental information, the proposed aquifer exemption application presents insufficient information on the potential that private well users could be currently drawing water from within the proposed aquifer exemption boundary. Based on the available information, EPA cannot grant this exemption based on 146.4(a).

Criterion 146.4(b)(1) Has Not Been Met

The applicant claims that the proposed aquifer exemption is justified based on the criterion at 40 CFR §146.4(b)(1), which states that an aquifer can be exempted if:

> *"(b) It cannot now and will not in the future serve as a source of drinking water because:*
>
> *(1) It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible."*

3

The applicant has not adequately demonstrated that this criterion has been met.

The supplementary information indicates that only twelve of the sixteen existing water disposal wells in the proposed aquifer exemption area have successfully produced oil. The remaining four "indicate the presence of oil within the area proposed for exemption." As we stated in our previous comments, it is not sufficient to simply demonstrate that hydrocarbons are present in the proposed exemption zone; the applicant must also demonstrate that those hydrocarbons are, or can be commercially producible, due to their size and location. The applicant has failed to demonstrate this throughout the entire proposed exemption volume.

Additionally, blanket assumptions regarding previous oil producing wells fails to adequately account for the remaining proposed aquifer exemption area (See Figure 1 in NRDC's comments on the Arroyo Grande aquifer exemption, submitted 21 September 2015). The supplementary information states that "there are 122 wells currently producing oil within the expanded area proposed for aquifer exemption." However, as we showed in our previous comments, the currently active wells - and therefore the location,

[3] http://www.epa.gov/region6/water/swp/groundwater/goliad-aquifer/transmittallettertotceq.pdf
[4] *Ibid.*

3 distribution, and recovery of the economically producible hydrocarbons - are overwhelmingly located within the already exempted portion of the proposed aquifer exemption. Currently, the zone outside the boundary of the existing exemption is host mostly to disposal wells.

4 Understanding a base water level and hydraulic conductivity, in combination with horizontal and vertical basin characteristics, is how groundwater flow directions are characterized. To reiterate, the applicant, supported by DOGGR and SWRCB, has not collected or presented any of this information, even after a public comment period where these issues were previously raised.

5 In our previous comment letter, we noted numerous deficiencies with the data the applicant claims shows that criteria 146.4(b) has been met, including deficiencies with the core, well log, and completions data. The supplementary information does not address these deficiencies.

3 The proposed aquifer exemption boundary must either be revised, the applicant must provide additional information to demonstrate that 40 CFR §146.4(b)(1) is met for the entire proposed exemption volume, or the applicant must rely on a different criterion to justify the exemption.

Containment Has Not Been Demonstrated

As noted in the supplementary information, California Public Resources Code §3131 requires aquifer exemption applicants to demonstrate that "the injected fluid will remain in the aquifer or portion of the aquifer that would be exempted." This has not been adequately demonstrated.

6 Basic characterization and understanding of the groundwater hydrogeology is critical to understanding the potential for hazardous contaminants to migrate off-site or interact with adjacent water users. None of this data has been collected or presented. The presence of a certain geological formation has no direct connection to groundwater flow without additional information. In other words, engineers and hydrogeologists cannot quantitatively predict groundwater flow based on geology and well logs alone, which is the only source of information throughout the proposed exemption.

It is unclear still whether the aquifer is confined or unconfined due to the lack of any supporting information necessary to determine head levels. The lack of groundwater flow directional data in the aquifer exemption petition suggests the groundwater flow regimes have not been established. In other words, the applicant does not understand the phreatic (or potentiometric) surface and the groundwater flow direction or groundwater flow velocities.

7 The injection balance considering the aquifer as a 'bowl' does not consider the horizontal and vertical heterogeneities of the aquifer and surrounding water users. Treating this system as a self-contained system where everything 'flows downhill' gravely underestimates potential for contaminants to migrate off-site into USDWs.

The application asserts: "The second layer of protection for nearby aquifers is that the bowl is surrounded to the east, south, and west with a layer of nearly impermeable siltstone and claystone called the Miguelito member of the Pismo Formation."

This statement is inconsistent and not supported by the presence of forty-six water wells drilled into the "Pismo Formation Aquifers," as shown in the map included with supplemental information (Figure 1: Locations of Water Supply Wells within the Vicinity of the Proposed Aquifer Exemption Boundary). In

other words, private users are actively using the Pismo Formation as a source of groundwater. By definition, an aquifer is a geologic body capable of storing and transmitting significant quantities of water. Therefore, since there's ample evidence that many users are currently discharging groundwater from this aquifer, the assertion that it is impermeable is highly questionable and lacks supporting data. There's no attempt to distinguish the Pismo Formation from the Miguelito Member of the Pismo formation around the project area (see cross-section A-A' of the supplemental information).

7

The supplemental information asserts that the juxtaposition of oil-bearing sandstones with lower permeability siltstone and claystone across the Arroyo Grande Fault will act as a barrier to migration of injected fluids outside the exempted zone of the aquifer. However, supplemental cross-section A-A' shows that Edna Member sands are present on both sides of the fault, and in fact are in direct contact across the fault in the shallower zones where the Arroyo Grande Fault splays.

8

The supplementary information still fails to define the intrinsic properties of the "tar seal" that would preclude the transmission of contaminants or potentially impaired groundwater outside the boundary of the proposed exemption. As we stated in our previous comments, the blanket assumption that this "tar seal" will act as an impermeable barrier indefinitely, particularly given the practice of steam injection used in the field, is grossly underestimating the potential for off-site migration of contaminants into USDWs and potential drinking water sources. Further, the supplementary comments still show the surface tar seal as a continuous unit but, as we stated in our previous comments, this is not consistent with geologic maps and cross-sections of the proposed exemption area.

9

Confinement on east and west side of the proposed exemption boundary has still not been adequately demonstrated. The supplementary information states that the "nearly impermeable siltstone and claystone" of the Miguelito member will prevent the movement of fluids. The supplementary information contains a single value of permeability – 1.7 milidarcies – for the entire Miguelito member, and no porosity data. It is geologically impossible that the entire Miguelito member has the same permeability throughout its entire extent. The supplementary information still does not contain any permeability or porosity maps, cross-sections, or well logs.

10

Beneficial Use Criteria Are Not Met

As noted in the supplemental information, California Public Resources Code §3131 requires that, "The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use." Neither the applicant nor the State has demonstrated that this criterion has been met.

As we stated in our previous comments, neither the Division and Water Boards nor Freeport-McMoRan have produced sufficient evidence that the portion of the aquifer proposed for exemption will not be of any beneficial use in the future. An analysis demonstrating the current and future technical or economic impossibility of beneficial use, based on levels of contamination, ease of access, technological availability of purification options and other factors is missing. In addition, we do not believe that the current data and proposed project operation practices demonstrate hydrologic isolation for the injectate.

11

To the contrary, it is clear that the water in the proposed exemption area is *currently* serving a beneficial purpose. The applicant is treating 21,000 bwpd of produced water at the Water Reclamation Facility ("WRF"), three quarters of which is discharged into Pismo Creek. As the applicant, DOGGR, and

SWRCB state, this discharge helps support habitat for the Southern California Steelhead and Tidewater Goby and recharges groundwater.

11 Ongoing injection activity could compromise these beneficial uses. The concentrated waste from the treatment facility is reinjected into the Arroyo Grande oilfield using the disposal wells. Neither the applicant nor DOGGR and SWRCB have analyzed the potential impact to the existing beneficial uses from the injection of this contaminated waste water.

Monitoring Well Issues

As aquifer exemptions are granted in perpetuity, the potential for injected contaminants to migrate offsite is uncertain; however from the currently available data presented in the aquifer exemption application, it's unclear where and when any potential off-site contaminant migration could occur, and what contaminants those might be.

12 The supplemental information indicates that adding "sentry groundwater monitoring wells" outside the proposed exemption boundary is being "considered." While we support the concept of enhanced monitoring, the supplementary information does not provide sufficient information to determine the adequacy of this monitoring program, or sufficient assurance that such monitoring will even take place. The requirement to perform monitoring must be included in the permit for the injection project. We also ask for clarification on the following issues:

13 • Given that no information regarding groundwater flow directions has been provided and basic groundwater direction vectors and magnitudes are unknown, how will the State determine where the wells will be placed?

14 • What depths and aquifers would be monitored?

15 • With what frequency and duration will the sampling occur? Given that groundwater transport can take years, and therefore, impacts to groundwater beyond the exemption boundary can occur years after the pumps are shut off and operations cease, monitoring needs to continue well beyond plugging and abandonment of the injection wells. Class VI regulations, for example, require monitoring for fifty years post-closure, unless operators can demonstrate that a shorter time frame is appropriate.

16 • There is no discussion about what water quality parameters would be sampled, what sampling and analysis protocols used, and what quality controls would be implemented. The applicant suggests that groundwater is already contaminated with various toxic compounds (i.e. BTEX, selenium, etc.), therefore, these and other constituents must be identified. We request a full suite of measurements from ICP-MS (heavy metal suite), HPLC (organics), GC (VOCs), and IC (anions, such as nitrates).

17 • We request a detailed baseline sampling procedure, what concentrations would constitute an 'impact', and what the remedies would be in case of a potential contaminant migration offsite into USDWs.

Conclusion

Both the original exemption application and the supplemental information fail to demonstrate that Federal and State requirements for granting an aquifer exemption have been met. We therefore request that the Division and Water Boards not submit the application to EPA.